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PART I. GENERAL (*Monthly*) PART II. POWER ENGINEERING (*Alternate Months*)
PART III. COMMUNICATION ENGINEERING (*Quarterly*)

PART I. GENERAL

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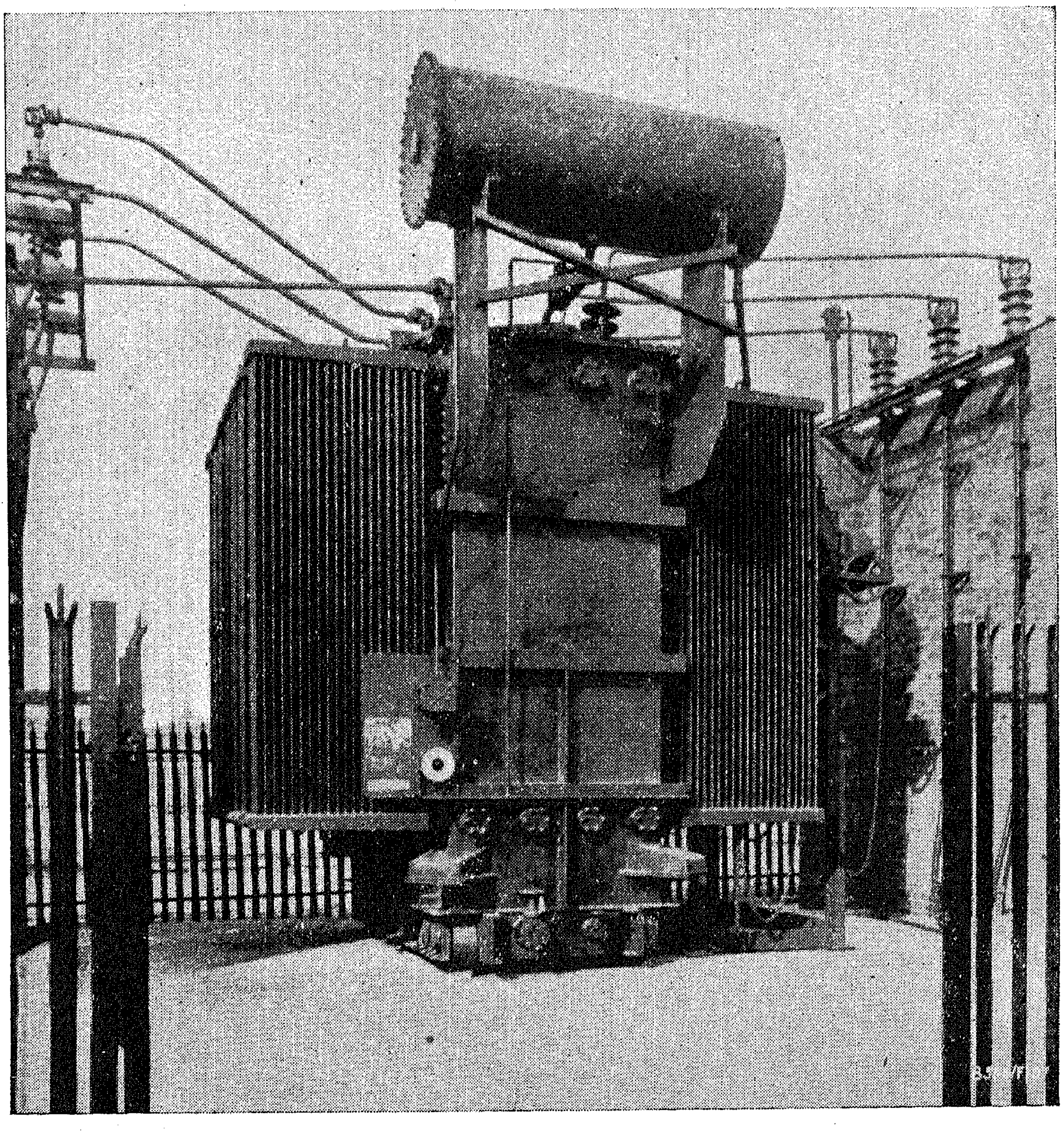

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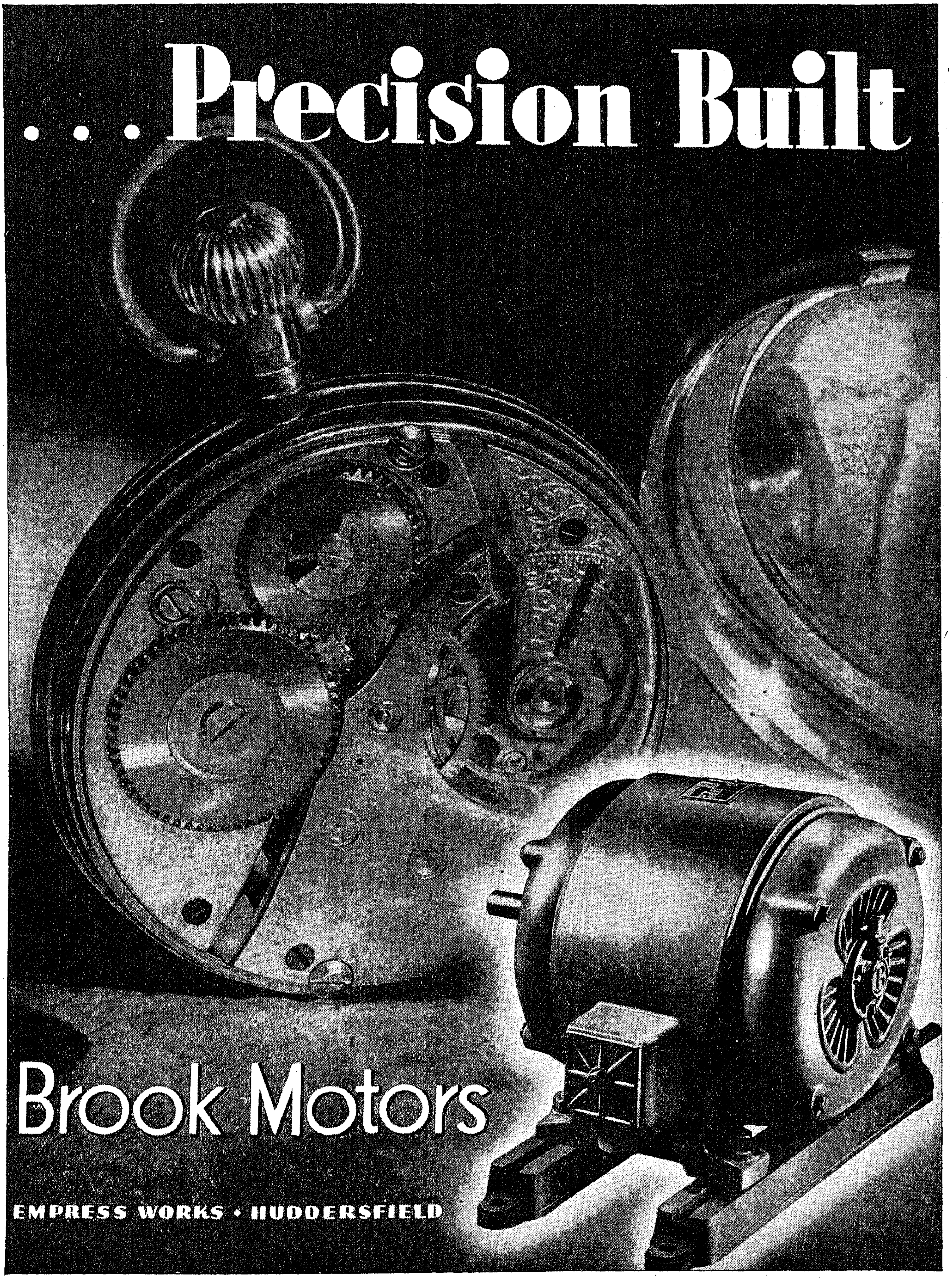
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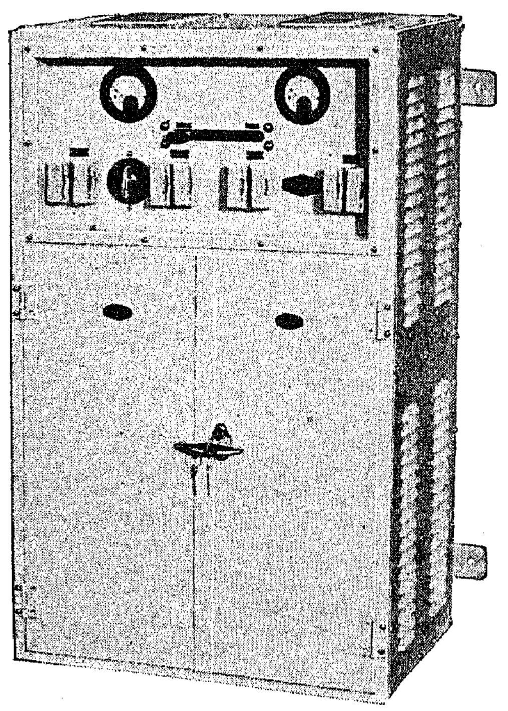

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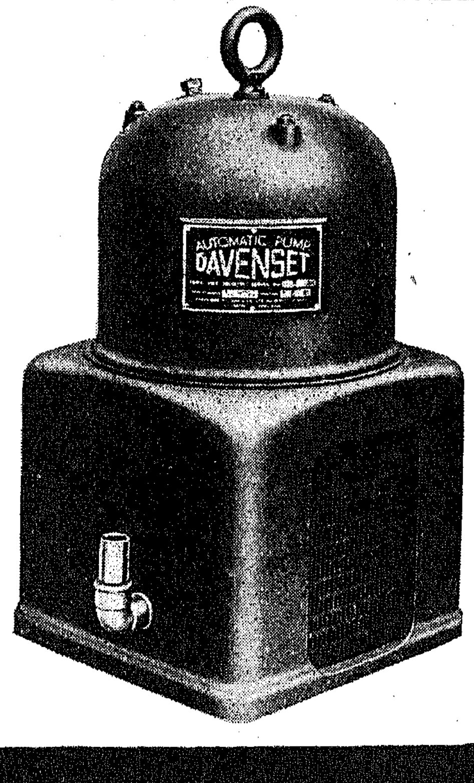

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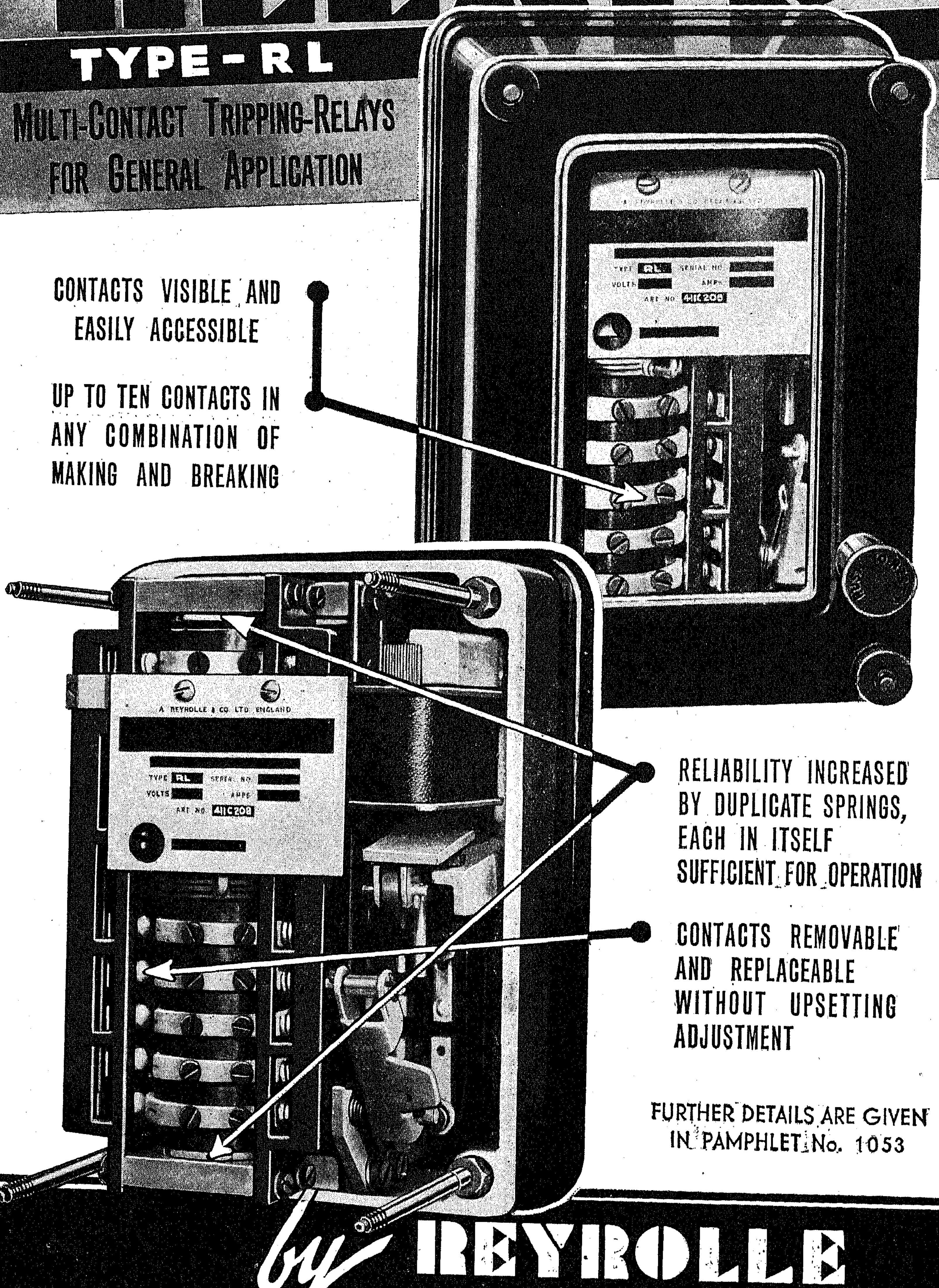

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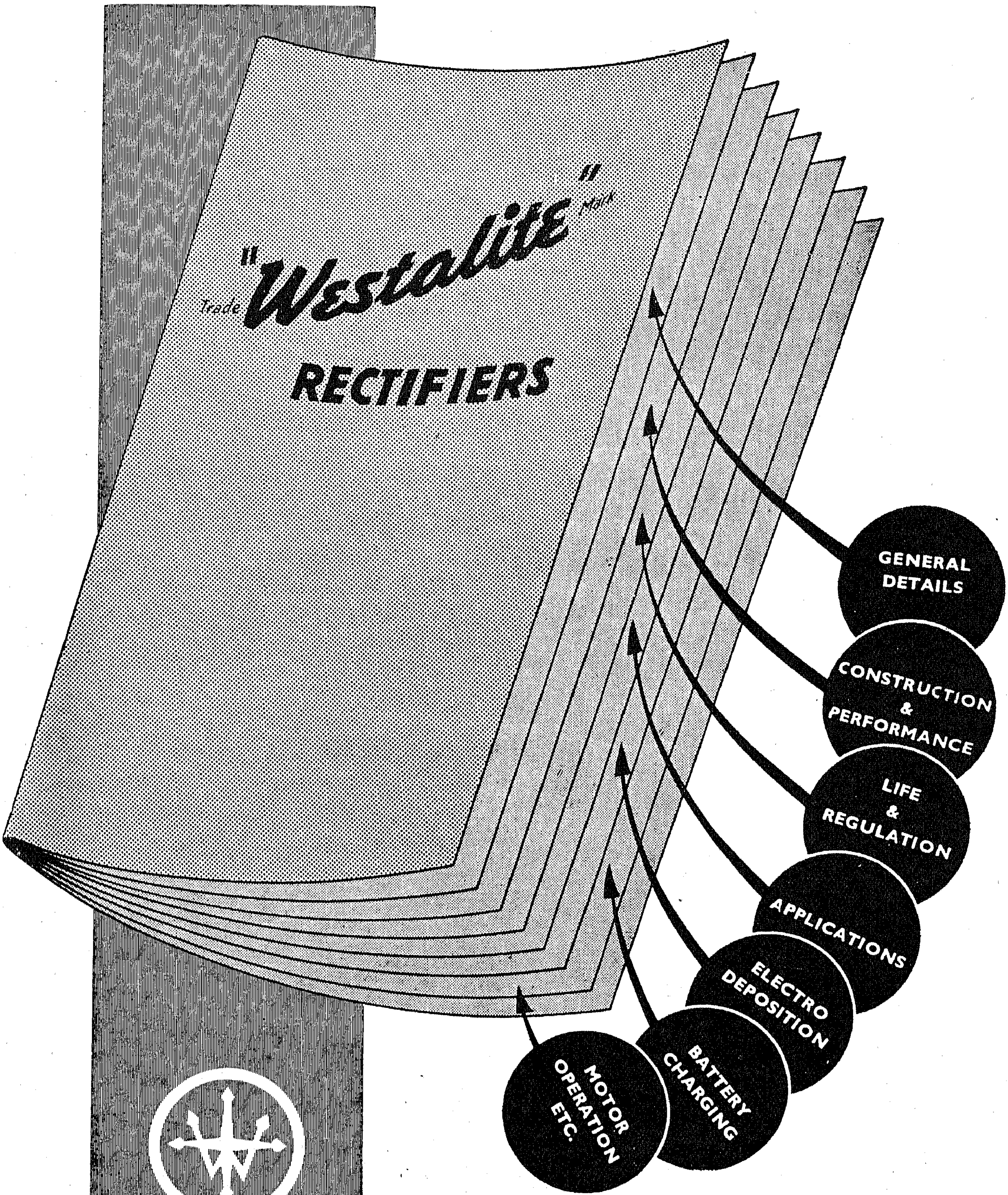

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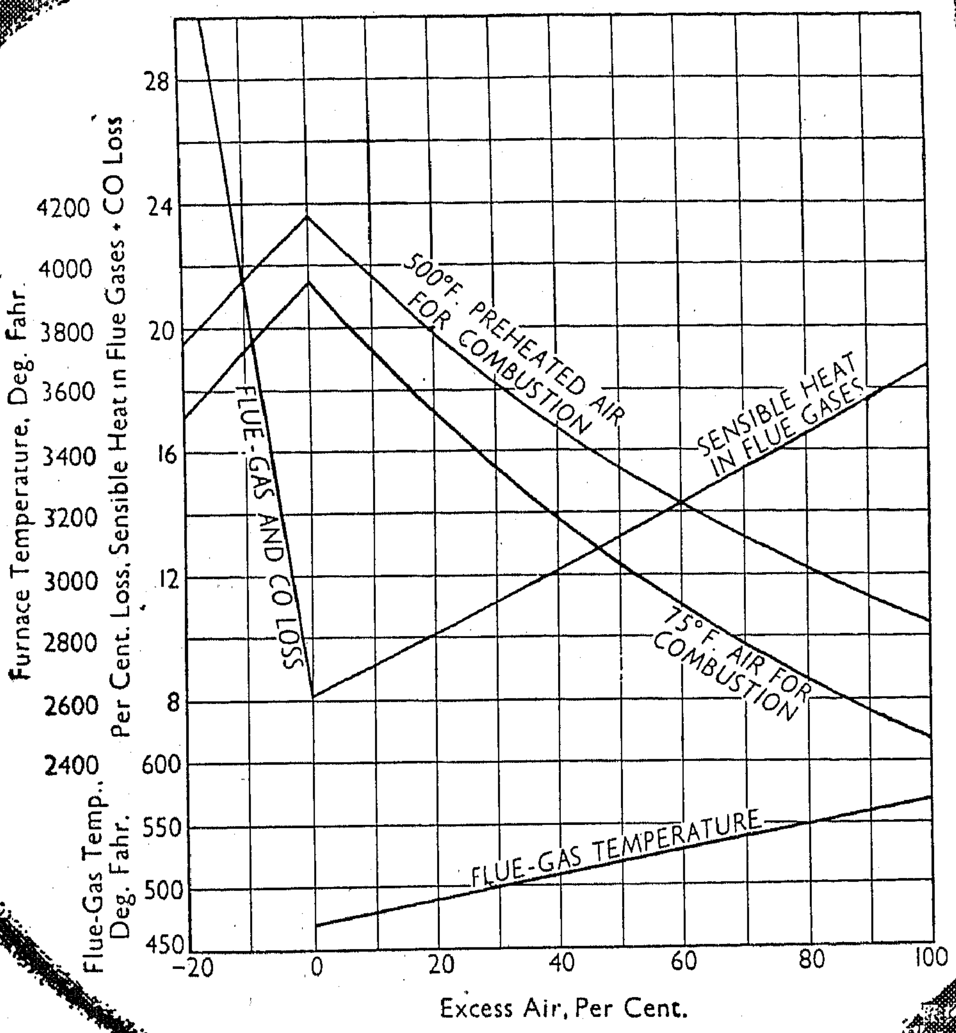

Curves showing relationship between excess air, theoretical temperatures of combustion of coal, flue gas temperatures and sensible heat in flue gases. From "Limiting Factors in Reducing Excess Air in Boiler Furnaces" by E. G. Bailey.

"THE flue gas temperature curve is taken from actual data, while the other curves of the figure are theoretical. It is seen that an increase in flue gas temperature occurs with an increase in percentage of excess air due to the higher velocity of the gases through the boiler and the lower rate of heat transfer by radiation when the initial temperatures are lower. It is noted that there is an increase in theoretical temperature of about 200°F. for each 10% reduction in excess air. Therefore, the percentage of excess air is a very important factor in controlling furnace temperatures for a given set of furnace conditions."

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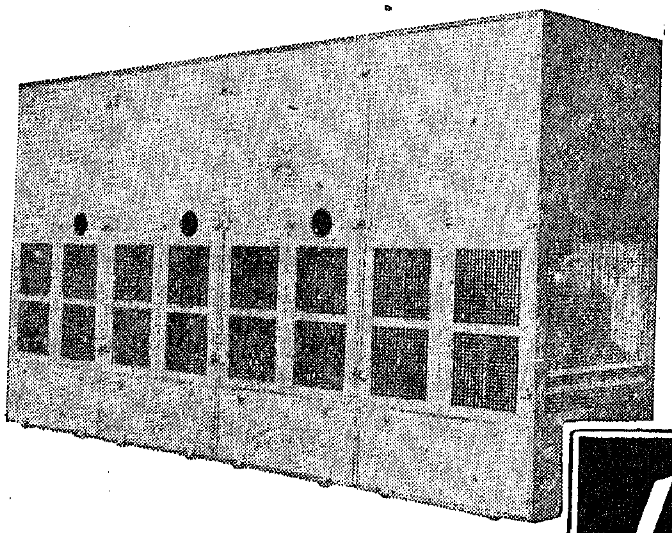

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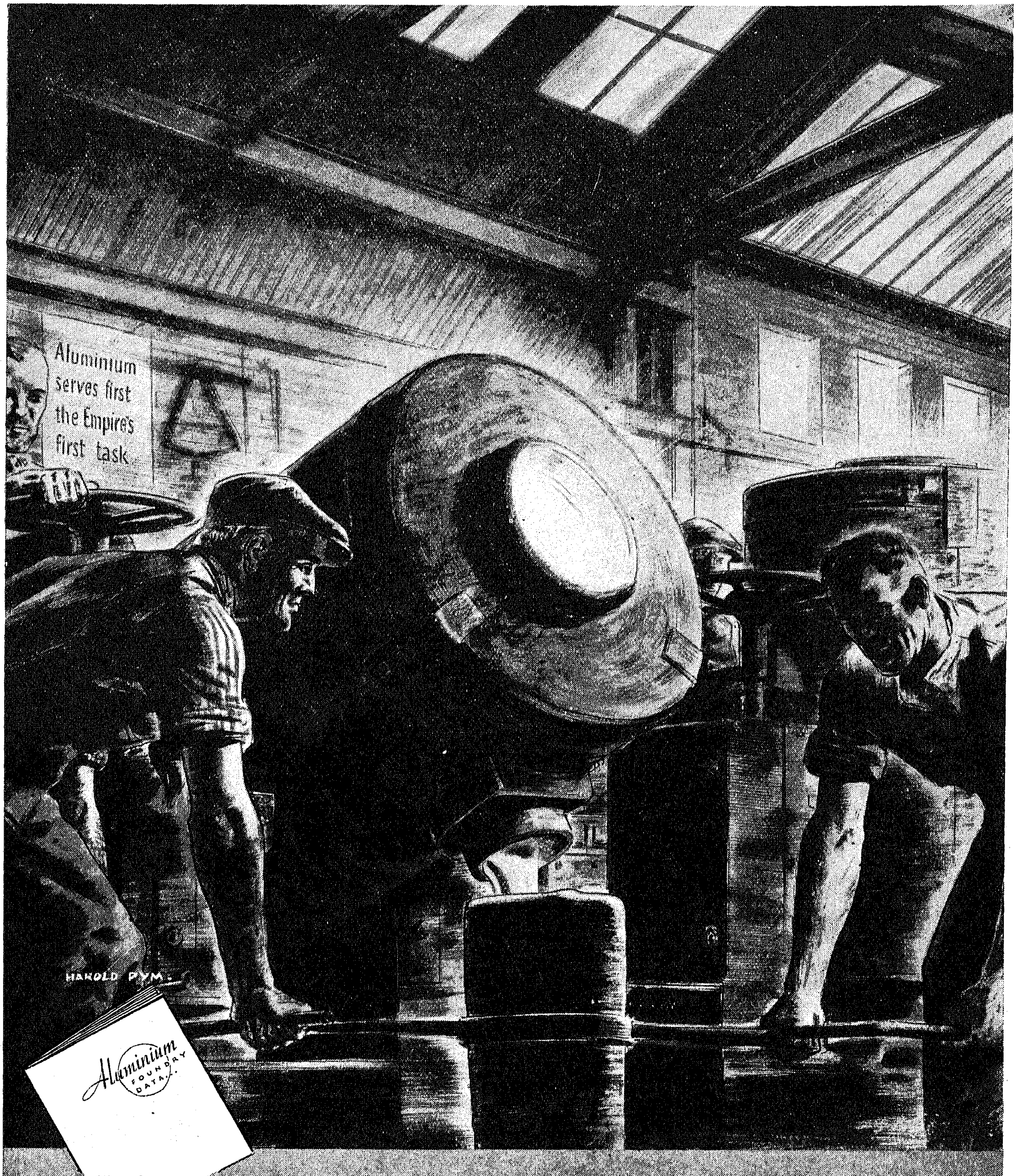
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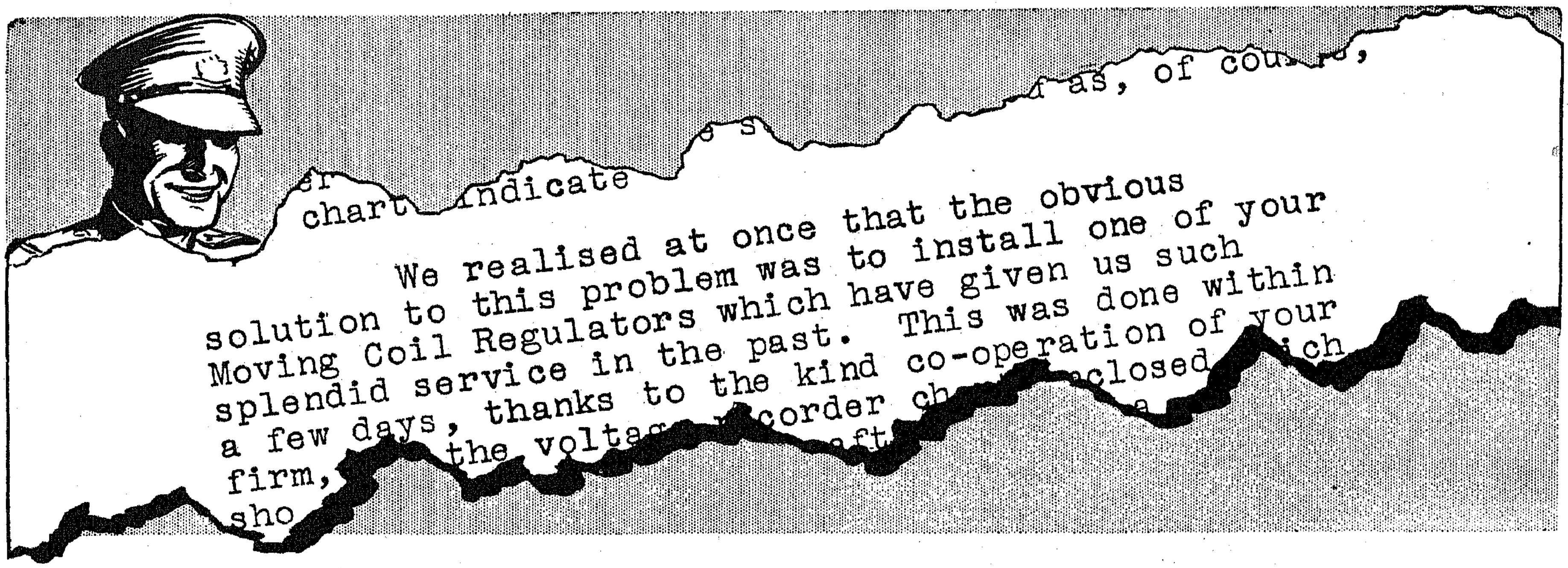

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A local hall, he writes, was recently taken over by the Military Authorities. They decided to cook by electricity, and pressure troubles of a very serious nature were soon experienced, as the attached chart indicates.

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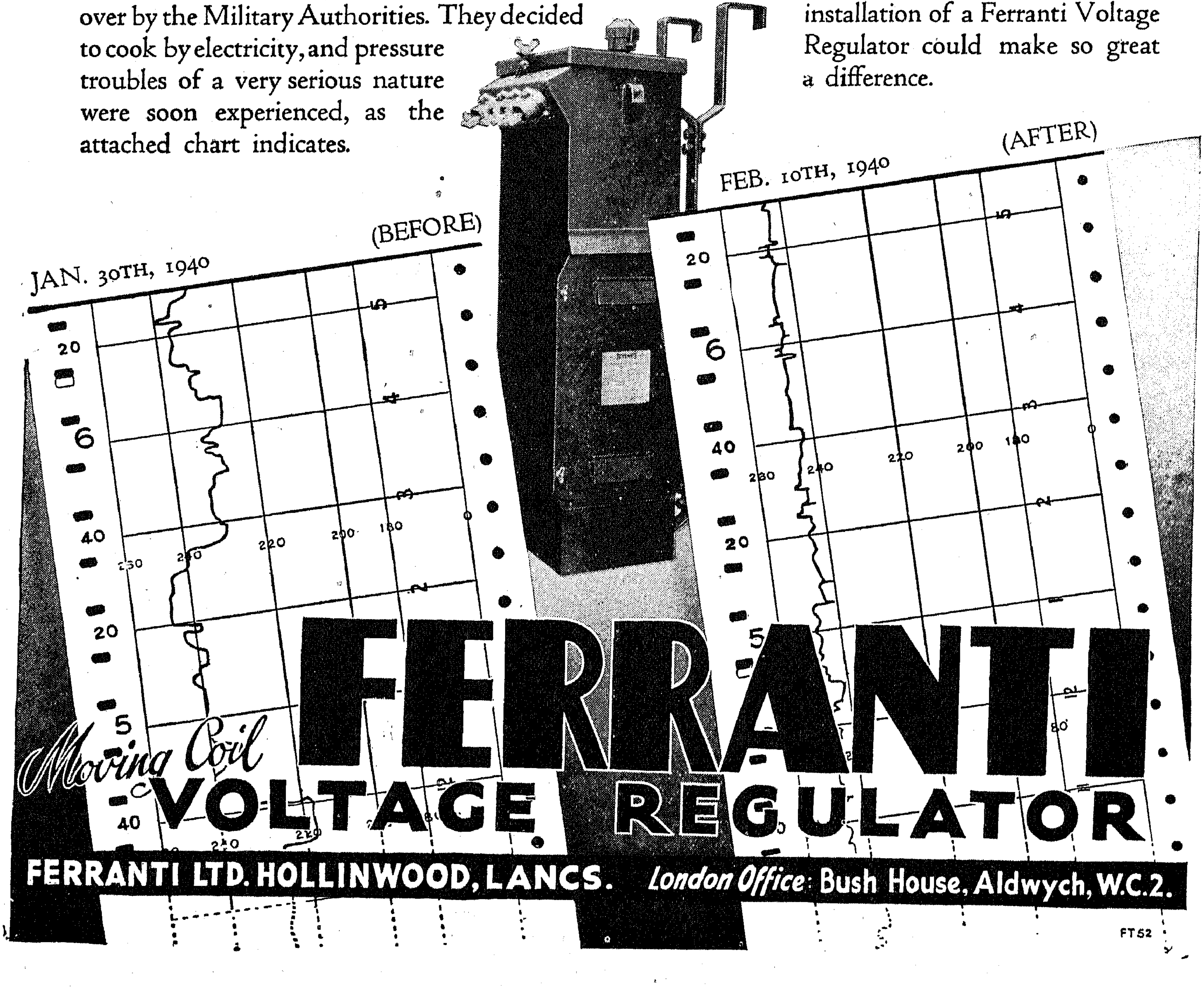

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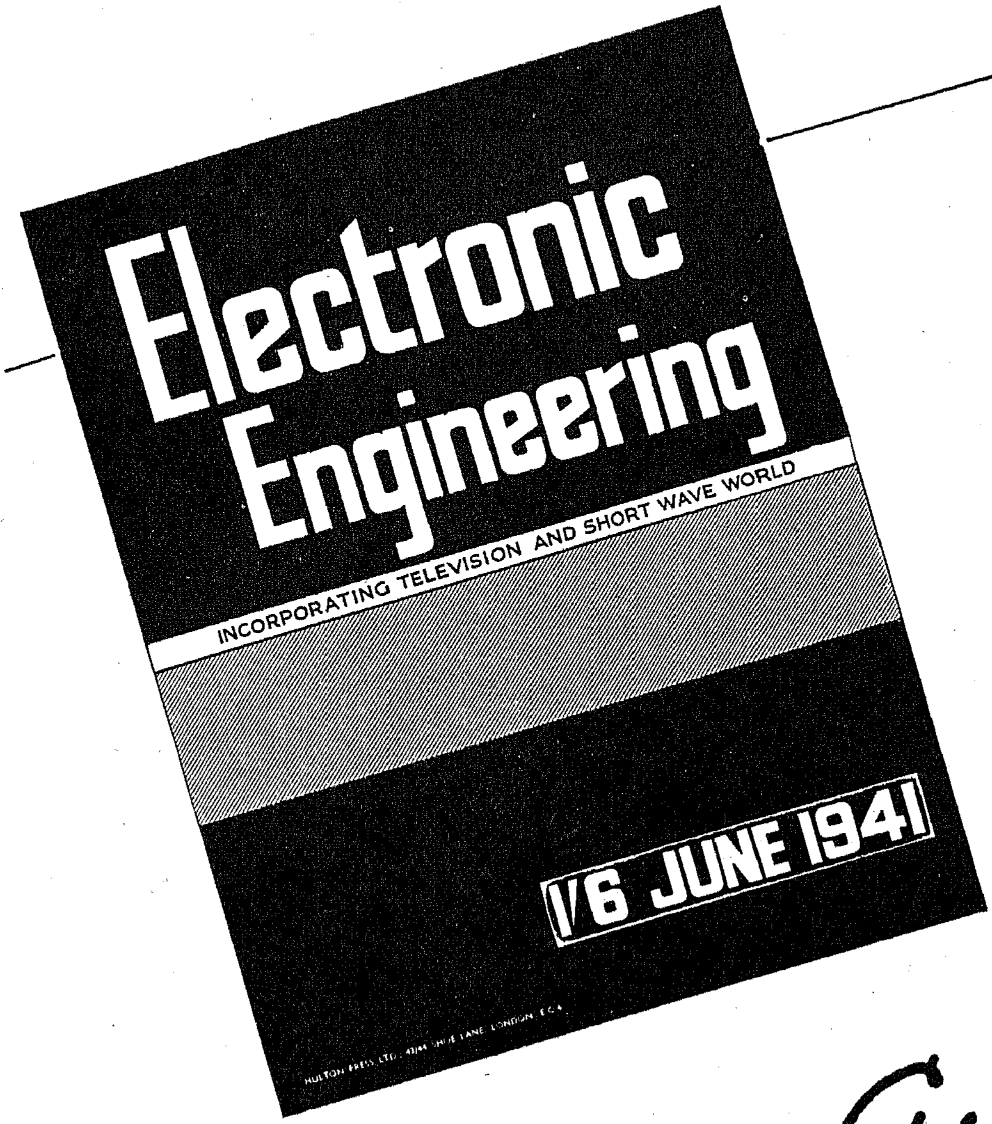

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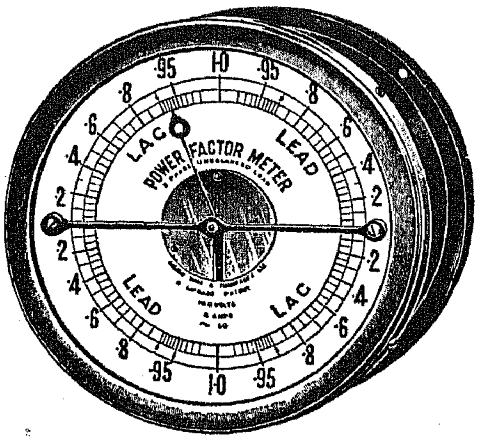

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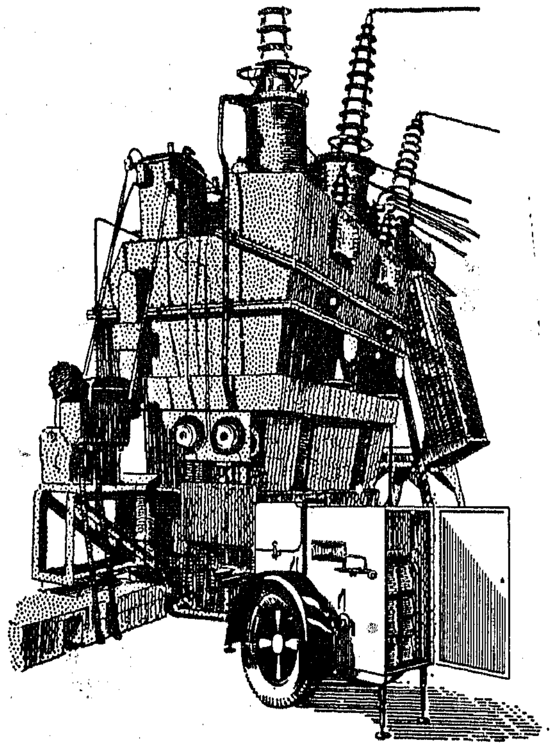

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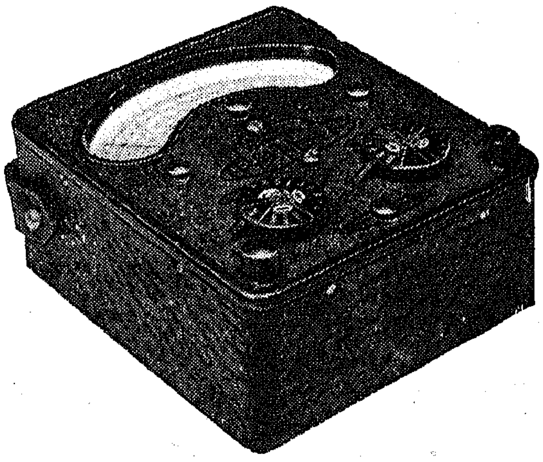

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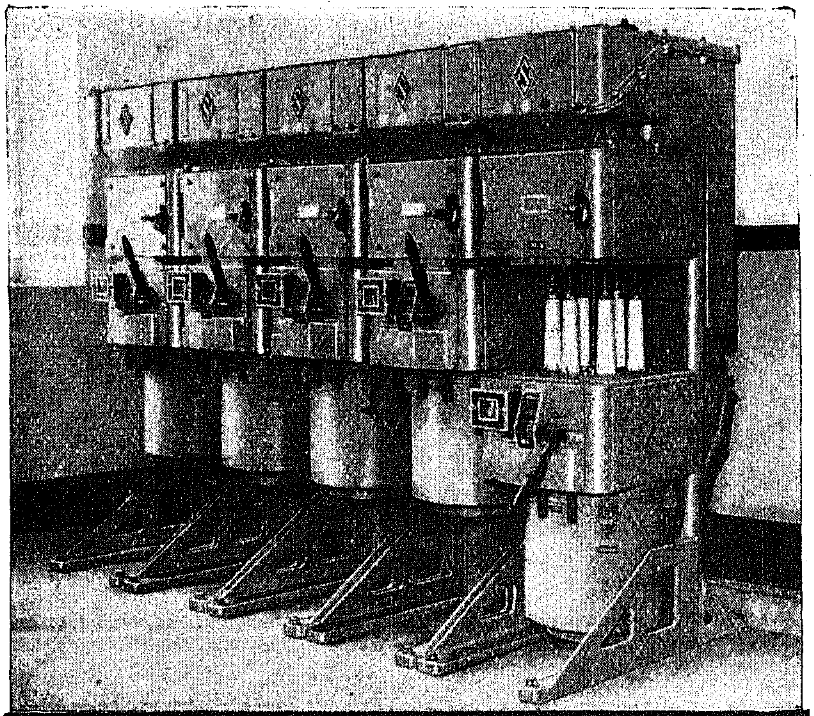

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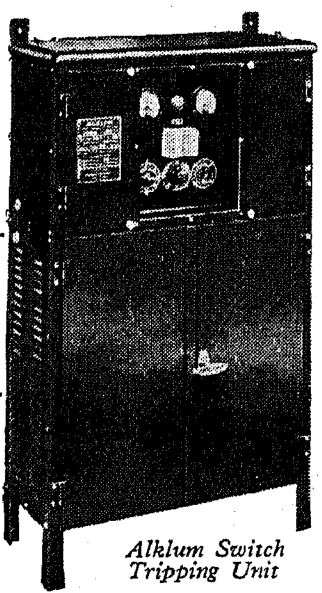

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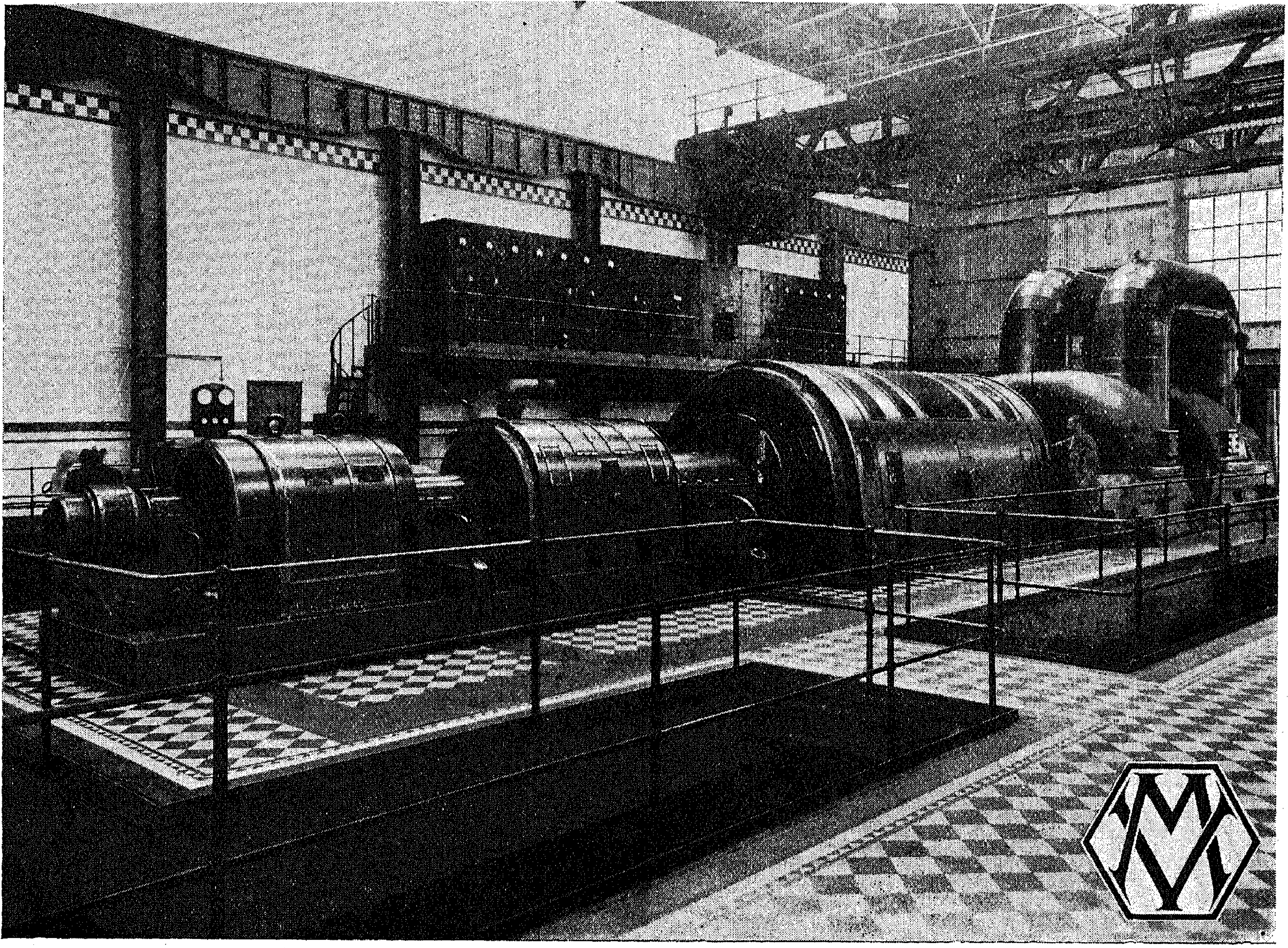

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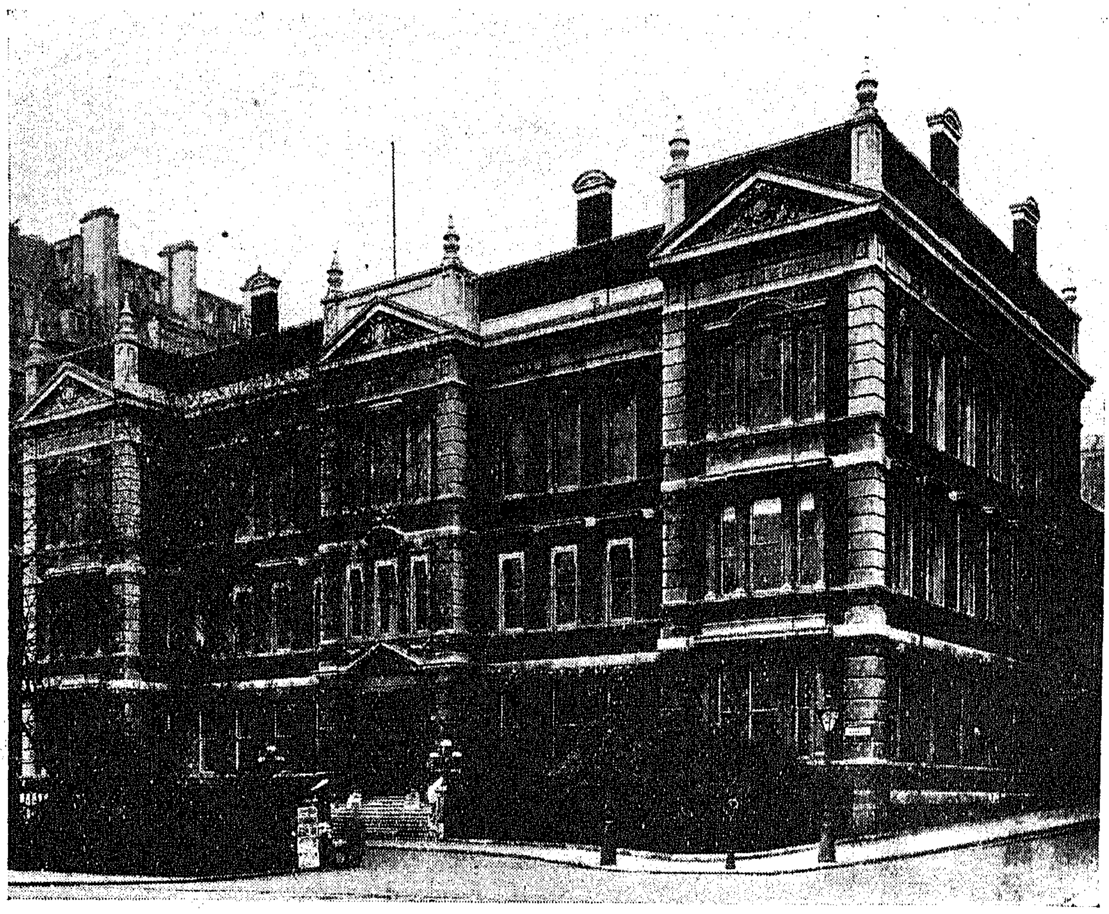

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THE JOURNAL OF
THE INSTITUTION OF ELECTRICAL ENGINEERS

EDITED BY W. K. BRASHER, SECRETARY

VOL. 88. PART I (GENERAL), NO. 6. JUNE 1941

THE ENGINEERING ADVISORY COMMITTEE

The announcement by His Majesty's Government on the 30th April, 1941, that the Lord President of the Council, with the approval of the Prime Minister, had set up an Engineering Advisory Committee, has been received with much satisfaction by all engineers.

The widespread feeling that the fullest possible use was not being made of the professional engineering ability in this country in the present emergency gave rise a year ago to the dispatch of a letter to the Prime Minister, signed by the Presidents of the Institutions of Civil, Mechanical and Electrical Engineers, placing the whole resources of their Institutions at the disposal of the Government.

Towards the end of 1940 discussion with representatives of the Government made it clear that if any organization were to be set up which could increase the contribution of engineering to the war effort an essential factor would be that all the varied branches of the profession should speak with one voice. The Council of The Institution of Electical Engineers therefore made a recommendation to the Engineering Joint Council that the constituent Institutions forming that body should unite in sending a letter to the Government on behalf of all the professional engineers in the country, pointing out the urgent necessity for calling on the engineering organizations, in addition to individuals, for help in the national war effort.

This proposal was accepted whole-heartedly and the Engineering Joint Council unanimously recommended that the Presidents of the engineering Institutions should address a joint letter to the Prime Minister, expressing their considered opinion that the engineering profession was not being used in a manner which would give such full assistance in the war effort as would be possible if the professional resources of the country were better co-ordinated, both within the industry and with scientists and Government Departments. Subsequently, the Government invited discussion with the Presidents of the Institutions of Civil, Mechanical and Electrical Engineers, during which it was emphasized that the desire of the profession was to further the war effort by constructive help and advice. Sir Leopold Savile, President of The Institution of Civil Engineers, at their annual luncheon on the day on which the public announcement of the formation of the Committee was made, expressed the debt of gratitude owed to Mr. J. R. Beard, our President, who, at the request of the other Institutions, had acted as the focal point on behalf of the profession; our own members will echo these thanks to Mr. Beard.

The Government's selection of the engineers to serve on the Committee inspires confidence that the best advice will be obtained on engineering matters in the widest sense, involving, as engineering does, such subjects as industrial research; the influence of special requirements upon manufacture; design for manufacture, inspection and tests; production at ever increasing speed and all that is involved therein; training of labour and technical assistants; all the wide knowledge and experience possessed by engineers qualified to be consulted. The terms of reference are both wide and specific; they require initiative by the Committee as well as the answering of questions submitted to them. The Committee is a responsible one and behind it are thousands of qualified engineers.

In recent years there have been notable expressions of aspirations to closer co-operation between the different specialists in engineering Institutions and considerable advance has been made. The Local Associations, Branches and Centres in the country and overseas have, however, led the way in the matter of systematic co-operation in meetings, discussions and the ability to express locally the opinion of professional engineers as a whole, and now, the stress of war acting as a catalyst, the engineering Institutions have quickly come together as one organization which is engaged on problems of major importance for defence. The enemy having chosen "to focus all his powers upon" the operation of the war machine "and co-ordinate its functioning by the same carefully drawn schedules that characterize industry, he leaves little choice but for other nations to adopt the same concerted methods as himself."[*]

In the difficult period after the war the genius of professional engineers will find plenty of work more suited to their creative abilities and it is to be hoped that, from now on, a permanent central engineering council will find a firm place in the national life.

F. G.

---

[*] F. B. JEWETT and R. W. KING: "Engineering Progress and the Social Order," Address before the Bicentennial Conference of the University of Pennsylvania Section on Natural Sciences, Philadelphia, 19th September, 1940.

INSTITUTION NOTES

ADDITIONAL ORDINARY MEETINGS

Additional Ordinary Meetings of The Institution have been arranged as follows:—

Thursday, 26th June, 1941, at 6 p.m.

(Light refreshments at 5.30 p.m.)

The following two papers will be read and discussed:—

"Metal Rectifiers," by A. L. Williams, Ph.D., M.Sc., and L. E. Thompson, B.Sc.

"The Characteristics and Applications of the Selenium Rectifier," by E. A. Richards, B.Sc.(Eng.), Associate Member.

Advance copies of the papers will be obtainable about 7 days before the meeting, on application to the Secretary, who would be obliged if members wishing to take part in the discussion would advise him in advance.

Thursday, 10th July, 1941, at 12.30 p.m.

A formal Ordinary Meeting will be held for the purpose of carrying out a ballot in respect of the candidates whose names will be suspended at the Ordinary Meeting on the 26th June, 1941. Only Corporate Members and Associates are eligible under the Bye-laws to participate in the ballot.

INFORMAL MEETINGS

The daylight facilities now available have afforded the opportunity to arrange two Informal Meetings, and the Council and the Informal Meetings Committee hope that members will take this opportunity of keeping in touch with Institution activities and meeting their fellow members.

The first of these meetings was held on the 26th May when the President (Mr. J. R. Beard, M.Sc.) opened a discussion on "Looking Forward."

The second meeting will be held on Monday, 30th June, at 6.30 p.m., when there will be a discussion on "The Continuity of Essential Electrical Services under Present Conditions" (to be opened by Mr. A. J. Gibbons, B.Sc.).

INSTALLATIONS SECTION

It will be noted from the Report of the Council for the year 1940–41 (see page 220) that the proposal to set up an Installation and Utilization Section of The Institution, which was well advanced at the outbreak of the war, has recently been under review. Not only would such a Section fill a definite place in the activities of The Institution, but attention has recently been drawn to the importance during the post-war reconstruction period of that sphere of The Institution's work which would be covered by the proposed Section.

The Council have therefore decided that the new Section be set up forthwith, under the title of the Installations Section, and that it be conducted on the lines of the existing Wireless, Meter and Instrument and Transmission Sections.

Members of any class of The Institution may apply for membership of the Section and no supplementary subscription will be payable in respect of such membership. Those desiring to become members must satisfy the Section Committee that they are actively engaged in work coming within the scope of the Section as shown below, and for this purpose they should complete the form which has now been circulated.

It is hoped that it will be possible to make an announcement about the first meeting of the Section in the July issue of Part I of the *Journal*.

SCOPE OF THE INSTALLATIONS SECTION

The Section shall have within its scope all matters relating to the study, design, manufacture, construction, installation, maintenance, operation and employment of equipment and apparatus used in electrical installations inside and outside buildings, including those for lighting, heating, ventilating and domestic purposes, and for general industrial, agricultural, mining and marine applications, but excluding matters relating to heavy engineering and functions lying within the scope of the Wireless, Meter and Instrument and Transmission Sections.

COUNCIL'S NOMINATIONS FOR ELECTION TO THE COUNCIL

The following have been nominated by the Council for the vacancies which will occur in the offices of President, Vice-President, Honorary Treasurer and Ordinary Members of Council, on the 30th September next:—

President

Sir Noel Ashbridge, B.Sc.(Eng.).

Vice-President. (*One vacancy.*)

Prof. S. Parker Smith, D.Sc.

Honorary Treasurer

E. Leete.

Ordinary Members of Council

MEMBERS. (*Two vacancies.*)

Lieut.-Col. S. E. Monkhouse.
F. Parkinson.

ASSOCIATE MEMBER. (*One vacancy.*)

S. E. Goodall, M.Sc.(Eng.).

The Council desire to point out that it is competent for Members (M.I.E.E.) and Associate Members (A.M.I.E.E.), subject to the conditions laid down in Bye-laws 36 and 50, to nominate other qualified persons to fill the above vacancies. The requisite qualifications and procedure are set out in Bye-laws 44–50.

ENGINEERING ADVISORY COMMITTEE

The Lord President of the Council, with the approval of the Prime Minister, has appointed an Engineering Advisory Committee under the chairmanship of Lord Hankey to advise the Government upon engineering questions connected with the war effort and in particular:—

(1) To consider how the resources of the engineering profession can best be utilized in connection with the war work of Government Departments; and to nominate engineers who might suitably be invited to undertake particular tasks;

(2) To suggest means of improving or supplementing the methods adopted by Government Departments for utilizing engineering science for war purposes;

(3) To advise on problems referred to them in connection with the development of new engineering devices; and to advise, as required, on methods of bringing such devices speedily into production and on means of meeting new war requirements in the engineering field;

(4) To examine new ideas or devices in engineering likely to assist the war effort, to test their technical validity, and to bring to the notice of the Government those which appear to merit further consideration by the Department concerned.

The Committee will consist of Rt. Hon. Lord Hankey, G.C.B., G.C.M.G., G.C.V.O., Chancellor of the Duchy of Lancaster (*Chairman*); Rt. Hon. Viscount Falmouth, M.I.Mech.E. (*Vice-chairman*); Sir Henry Tizard, K.C.B., F.R.S., F.R.Ae.S., F.Inst.P.; and the following members who have been selected after consultation with the Presidents of the Institutions of Civil, Mechanical, and Electrical Engineers:—J. R. Beard, M.Sc., M.Inst.C.E., M.I.E.E., Dr. A. P. M. Fleming, C.B.E., M.I.Mech.E., M.I.E.E., F.Inst.P., W. T. Halcrow, M.Inst.C.E., B. W. Holman, O.B.E., A.R.S.M., M.I.Mech.E., M.Inst.Chem.E., Dr. C. C. Paterson, O.B.E., M.I.E.E., F.Inst.P., H. R. Ricardo, B.A., F.R.S., A.M.Inst.C.E., M.I.Mech.E., Principal A. Robertson, F.R.S., M.I.Mech.E.

Representatives of the Government research establishments and production departments will be associated with the Committee as required from time to time.

NATIONAL SERVICE

As there have been several instances in which Chartered Electrical Engineers, when called upon to register under the Military Service Acts, have not claimed their right to appear before a University Joint Recruiting Board, attention is again directed to the importance of this matter, in order to ensure that qualified men are not called up for general service in non-technical units.

The University Joint Recruiting Boards have been set up to ensure that men with suitable qualifications are reserved for technical employment in industry or Government service, or are allocated to technical units in His Majesty's Forces. Any Corporate Member or Graduate of The Institution, any graduate of a university, or any holder of a Higher National Certificate or Diploma, who is called upon to register should therefore ask when registering that he may appear before a Joint Recruiting Board. The Secretary will, on request, issue to members of any class a letter for presentation to the Registration Officer.

PREMIUMS

At the Annual General Meeting held on the 8th May the President announced that the Council had made the following awards of Premiums for papers during the 1940–41 Session:—

The Institution Premium (*value* £25).	
C. F. Booth	"The Applications and Use of Quartz Crystals in Telecommunications."
The Ayrton Premium (*value* £10).	
W. A. Cook, B.Sc.(Eng.).	"Outdoor Bushings — Their Construction, Testing and Standardization"
The Fahie Premium (*value* £10).	
A. Fairweather, M.Sc., and J. Ingham, M.Sc.	"Subsidence Transients in Circuits containing a Non-Linear Resistor, with reference to the Problem of Spark-quenching."
The John Hopkinson Premium (*value* £10).	
G. H. Rawcliffe, M.A.	"The Secondary Circuits of Synchronous Induction Motors."
The Kelvin Premium (*value* £10).	
C. E. R. Bruce, M.A., B.Sc., and R. H. Golde	"The Lightning Discharge."
A Premium (*value* £10).	
C. G. Garton	"Dielectric Loss in Thin Films of Insulating Liquids."
A Premium (*value* £5).	
W. J. Mason and S. A. G. Emms, B.Sc.	"Electricity in Paper Mills."
A Premium (*value* £5).	
R. Jessel, Ph.D.	"Factors in the Design of Electric Heating Elements."
A Premium (*value* £5).	
G. H. Metson, M.Sc., B.Sc.(Eng.).	"An Alternative Treatment of the Attenuation of Waves in a Coil-loaded Telephone Line."
A Premium (*value* £5).	
L. Gosland, B.Sc., and W. F. M. Dunne, B.Sc.	"Transients of Restriking Voltage on Overhead-Line Systems."
A Premium (*value* £5).	
A. Langley Morris	"The Influence of Various Factors upon the Leakage Reactance of Transformers."
A Premium (*value* £5).	
Prof. Willis Jackson, D.Sc., D.Phil., and A. E. Chester, M.Sc.	"The Extraction of Electrons from Cold Metals at High Field-Strengths."

Wireless Section Premiums

The Ambrose Fleming Premium (*value* £10).	
N. M. Rust, O. E. Keall, J. F. Ramsay, M.A., and K. R. Sturley, Ph.D., B.Sc.	"Broadcast Receivers: A Review."
A Premium (*value* £10).	
C. A. Mason, B.Sc.(Eng.) and J. Moir	"Acoustics of Cinema Auditoria."
A Premium (*value* £5).	
R. H. Barfield, D.Sc.	"The Performance and Limitations of the Compensated Loop Direction-Finder."

Meter and Instrument Section Premiums

A Premium (*value* £10).

A. E. W. Austen, B.Sc., Ph.D., and S. Whitehead, M.A., Ph.D.	"Discharges in Insulation under Alternating-Current Stresses."

A Premium (*value* £5).

A. J. King, B.Sc.Tech., R. W. Guelke, Ph.D., C. R. Maguire, B.Sc., and R. A. Scott, Ph.D.	"An Objective Noise-Meter reading in Phons for Sustained Noises, with special reference to Engineering Plant."

Transmission Section Premiums

The Sebastian de Ferranti Premium (*value* £20).

F. R. Perry, M.Sc.Tech.	"The Measurement of Lightning Voltages and Currents in South Africa and Nigeria, 1935 to 1937."

A Premium (*value* £10).

C. Dannatt, D.Sc., and R. A. Polson, B.E.	"A Method for determining the Restriking Characteristics of Power Networks whilst in Service."

The awards for papers before the Students' Sections will be announced later.

LOCAL CENTRE ACTIVITIES

North-Western Centre.

At the Annual General Meeting of the Centre held on the 19th April, the following were elected to fill the offices which will fall vacant on the 1st October next.

Chairman	H. C. Turner, J.P.
Vice-Chairman	C. T. D. Arnett, B.Sc.
Hon. Secretary	L. H. A. Carr, M.Sc.Tech.
Ordinary Members of Committee	W. Kidd, J. L. Miller, D.Eng., Ph.D., A. J. Nicholas and H. West.

The Annual Report of the Committee was presented at the meeting and it showed that the total membership of the Centre now exceeds 1 500.

At the Ordinary Meeting which followed, and which was the last of the session, two papers were presented, namely "The Measurement of Lightning Voltage and Currents in South Africa and Nigeria" by F. R. Perry, M.Sc.Tech. (see *Journal I.E.E.*, **88**, Part II, p. 69), and "The Lightning Discharge," by C. E. R. Bruce, M.A., B.Sc., and R. H. Golde. All the three authors were present and a spirited discussion followed.

To assist in raising funds for the Benevolent Fund a half-day Golf Tournament has been arranged for Saturday, 14th June, on the links of the Didsbury Golf Club. The Manchester Challenge Cup will not be played for, the competition being limited to a four-ball better-ball competition, and a putting competition. Mr. A. L. Green, the Assistant Secretary of the Centre, is acting as Hon. Secretary for the Tournament.

In March the North-Western Students Section reverted to Tuesday evening meetings, the time being advanced to 6 p.m., and on the 25th March a "Problems Evening" was held, while on the 29th April Mr. E. Jacks read a paper entitled "Electricity on Tap." The session closed with the Annual General Meeting held on the 13th May.

Scottish Centre.

The Annual General Meeting of the Centre was held on Tuesday, 15th April, 1941, at the Heriot-Watt College, Edinburgh. The Chairman moved the adoption of the Report and Accounts and, in commenting thereon, referred to the success which had attended the series of informal papers which had been presented during the past session. The authors of these papers, with two exceptions, were members of the Centre. Interesting and lively discussions had resulted in every case. The Committee hoped to draw up a programme for next session on similar lines.

Nine meetings in all had been held, five in Glasgow and four in Edinburgh, and it was fortunate that all had been carried through without interruption by air-raid warnings. All the meetings were held jointly with the Scottish Students' Section. The adoption of the Report was seconded by Mr. D. S. Munro and approved.

Following the Annual General Meeting the Ninth Ordinary Meeting of the Centre was held jointly with the Students' Section, when Colonel B. H. Leeson, R.E., read an informal paper entitled "Recent Development in Switchgear." The paper was illustrated by lantern slides, and an interesting discussion followed. In replying to the vote of thanks, Col. Leeson paid a tribute to the late Mr. H. W. Clothier as the father of the British ironclad switchgear.

The Annual General Meeting of the Scottish Students' Section was held at the Heriot-Watt College, Edinburgh, concurrently with that of the Centre, the members present afterwards attending the joint Ordinary Meeting. The Report and Accounts were presented and adopted. Since no nominations had been received the Committee nominees were duly elected.

Northern Ireland Sub-Centre.

The April meeting of the Sub-Centre had, unfortunately, to be cancelled, owing to Mr. Macrory, the author of the paper which was to have been read and discussed, being unable to visit Belfast.

The Annual General Meeting was held on the 27th May.

ADDRESS PRESENTED TO THE ENGINEERING INSTITUTE OF CANADA

The following is the wording of the Address which, as recorded in the "Proceedings of The Institution" on page 233 of this issue, has been presented to The Engineering Institute of Canada to record the occasion of the presentation by the President of The Institution, on behalf of The Engineering Institute of Canada, of the Sir John Kennedy Medal to Lieut.-General A. G. L. McNaughton, C.B., C.M.G., D.S.O., M.Sc., LL.D., D.C.L., General Officer Commanding the Canadian Forces in Great Britain:—

The President, Council and Members of
The Institution of Electrical Engineers,

on the occasion of the Ordinary Meeting of The Institution held on Thursday, 8th May, 1941, wish to place on record their appreciation of the invitation received from

The Engineering Institute of Canada

that The Institution should, on their behalf, present to Lieut.-General A. G. L. McNaughton, C.B., C.M.G., D.S.O.,

the
Sir John Kennedy Medal

awarded to him for "his noteworthy contribution to the science of engineering."

Since some years before the outbreak of the present war this Institution had advocated and fostered closer co-operation between Engineering Institutions in Great Britain and their sister Institutions in the overseas countries of our Commonwealth of Nations; the opportunity to carry out this ceremony on behalf of The Engineering Institute of Canada has therefore been especially welcome at a time when activities towards that co-operation have necessarily had to be curtailed. It adds to the Council's pleasure in arranging this ceremony that General McNaughton has long been an Associate Member of The Institution of Electrical Engineers.

The members present at this meeting extend a hearty welcome to General McNaughton and offer him their warm congratulations, not only on the signal honour in the engineering field conferred on him by the award of the Medal, but on the great distinction which he has achieved in a wider sphere by his appointment as head of the Canadian Forces in Great Britain during the present momentous conflict.

The contribution which is being made by Canadian Engineers to the war effort is recognized to be one of inestimable value in the vital place that is being taken by Canada in the cause of freedom at the side of the Mother Country.

A facsimile copy of this Address is being handed to-day to General McNaughton in commemoration of the occasion of the presentation to him of the Medal.

WITNESS our hands and seal at Westminster this Eighth day of May, 1941.

Seal
of The
Institution

James R. Beard, *President.*
Johnstone Wright, *Past President.*
W. K. Brasher, *Secretary.*

ARMY OFFICERS EMERGENCY RESERVE

The Secretary has been asked by the War Office to draw the attention of members to the following copy of a letter which recently appeared in *The Times*:—

> While the main source of supply for the Army has been the Officer Cadet Training Units, which are themselves filled by men selected from the ranks, a very large number of commissions have been granted through the Army Officers Emergency Reserve, mainly to those who had already served in the last war, or to those required in appointments in which some special technical qualifications are needed rather than military experience or training.
>
> Last year a comprehensive organization for interviewing candidates was set up. Candidates for technical arms are interviewed by selected officers of those arms while those without special technical qualifications are seen by Interviewing Boards which have been established in London and many provincial centres. A notable addition to these Boards has been the inclusion of a civil member of wide industrial or commercial experience. The advice and assistance which these gentlemen have been able to give has been of the greatest value.
>
> It is often forgotten that the Army Officers Emergency Reserve is intended to be a reserve from which gentlemen can be called up for commissioning as they are required. It is not, and was never intended to be, an employment bureau which can undertake to find employment for applicants.
>
> Registration in the A.O.E.R. carries no guarantee of employment and no candidate should give up any other form of employment merely because he has been accepted for registration. Whether any member of the Reserve is called up, and when, must depend upon his qualifications and medical category and on the varying demands for the different classes of Officer. In some cases there is a large reserve registered, in others, more particularly for Royal Engineers, Royal Army Service Corps, and Royal Army Ordnance Corps, demand is large and continuous and suitable candidates in certain classes for these Corps are usually called up soon after registration. The Pioneer Corps also makes considerable demands to meet its growing needs.
>
> The A.O.E.R. is still open to receive applications from those who have not yet felt able to offer their services. For obvious reasons the number of vacancies in each Corps cannot be stated, but candidates accepted for registration for a technical arm would probably be called up for service in no long time after registering.

BRITISH STANDARDS

The Secretary has been requested by the British Standards Institution to draw attention to the following new and revised specifications, copies of each of which can be obtained from the B.S.I., 28 Victoria Street, London, S.W.1, price 2s. (2s. 3d. post free).

Electrical Performance of Transformers for X-Ray Purposes (B.S. No. 326).

A revision of this specification has recently been issued. The necessity for this revision arose from the fact that the specialized knowledge of the conditions appertaining to X-ray work had progressed considerably since the first issue of the specification, and that advantage should be taken of the expert knowledge now available to bring this specification up-to-date and make it of more practical value.

In addition to a number of alterations to the specification for the transformer itself, an appendix has been added dealing with the electrical performance of complete high-tension generators.

Daylight Fittings for Colour Matching (B.S. No. 950).

This specification is the result of considerable research work. The performance of a colour-matching fitting can be specified only by the adoption of some standard with respect to which the tolerances in the specification are expressed. It is clearly important that two coloured specimens which match under the standard illuminant adopted for colour matching shall also be equal under the conditions which are standard in colorimetry.

There are two principal standards, designated standard illuminant "B" and standard illuminant "C," which have been adopted by the International Commission on Illumination for colorimetric measurement. Of these the former is representative of sunlight or the yellower phases of daylight, whilst the latter is representative of average north skylight in Great Britain. It is clearly desirable that one or other of these standard illuminants in colorimetry should be the standard for colour matching. In order to ensure the minimum inconvenience in industrial practice the second of these illuminants, I.C.I. standard illuminant "C" has been chosen and the tolerances given in this specification for artificial-daylight lamps for colour matching are specified in relation to this source.

This specification requires that artificial sources for colour matching shall satisfy two conditions. The first is that the colour of the light shall fall within certain limits, and the second is that the difference between its spectral energy distribution and that of the standard as determined by an approximate filter method shall be within certain limits.

Considerable care was given to the Appendix which defines the filters, and the original proposals were slightly modified, after consultation with filter manufacturers, in order to give as much tolerance as possible without lowering the standard requisite for the necessary colour-matching requirements.

ELECTIONS AND TRANSFERS

At the Annual General Meeting of The Institution held on the 8th May, 1941, the following elections and transfers were effected:—

Elections

Associate Members

Ashford, James Leslie.
Base, George Cecil.
Bunn, Sidney Clarence.
Buxton, Simeon.
Cooper, Ernest George.
Copeland, Robert Harry, Major, R. Signals.
Dalal, Mehrwanji, B.Sc.
Gibson, Alexander Stephen, B.Sc.
Gossain, Amir Chand, Lieut., I.A.O.C.
Hardie, Alexander Merrie, M.A., B.Sc.
Henderson, James Lomas, Lieut.-Col., B.A.
Hopkins, Herbert Desmond, B.Sc.
Jones, Idris ab Gwilym, B.Sc.
Joslin, Stanley William, Lt.Col., B.A.
Lawton, Cyril.
Lee, George.
McAlister, James, B.Sc.
Meiklejohn, Ian Forbes.
Menzies, Thomas Edward D., B.Sc.
Norballe, Leslie Hans, B.Sc.
O'Doherty, John J., B.Sc.
Palmer, Dennis John.
Rissik, Hendrik, B.Sc.(Eng.).
Scott, Maurice.
Smee, John Francis.
Travis, George Frederick.
Ward, William.
Worthy, Leonard Frank.

Associates

Beresford, George.
Burford, Mark.
Burns, John.
Craven, Michael Henry.
Davies, Lionel James, B.Sc.
Ellis, Arthur Chambers.
Harland, Frederick William.
Harris, Frederick William C.
Jaeckel, Franz Otto.
Manton, James Arthur, Lieut., R.E.
Mayne, Eric Ivor.
Mitchell, Peter.
Moore, Cecil James.
Pritchard, Arthur Lennox.
Rough, George Stevens.
Salisbury, William John.
Sparrow, Frederick Stanley.
Varney, Reginald Louis.
Walker, Charles Henry.

Graduates

Anderson, Charles Vernon.
Arieli, Immanuel.
Ballentine, Reginald Lloyd.
Barton, Robert Frederick.
Bassadone, Albert Louis.
Bocking, Shirley Arthur.
Bonelle, Geoffrey James, B.Sc.
Burgmann, Victor Dudley, B.Sc.
Carrier, Mervyn Joseph A.
Chowdhury, Parimal Basu R.
Collingwood, Bryan.
Court, Edward Thomas.
Duerden, Francis, B.Sc.
Eden, Lionel Thomas.
Foster, John William, B.Sc.
Gotety, Venkata Sreeramamurty.
Jeffs, Eric Arthur.
Lovegrove, Richard Harris.
Lowther, Arthur Thomas.
Mathurawayagam, Mailvaganam.
Merriman, James Henry H., M.Sc.
Morphew, Allan Granby, B.Sc. (Eng.).
Murray, Thomas Lloyd, B.Sc.
Parry, David Wynn, B.Sc.
Phipps, Albert William.
Plen, Mark, B.Sc.(Eng.).
Powell, William Henry, B.Sc.
Procter, Kenneth, B.Sc.
Proudlock, Robert Victor, Major, Royal Signals.
Robinson, Thomas Stewart, B.Sc.
Salam, Mowaffaq Amin Al.
Schleissner, Hans.
Sims, Donald Henry.
Smith, Wilton Beresford.
Taylor, Charles Vincent, B.Sc.
Venkataraman, G.
Warner, Arthur Hugh W.
Wheeley, Gerald St. George, B.Sc.
Withers, Bernard Tyndall.

Students

Agarwal, Suraj Mal, B.Sc.
Agaskar, Laxman Sadashiv.
Ahmad, Mohammad Talkhis.
Ahmed, Kizshery Chaikku.
Allchin, Mervyn Cyril V.
Ansell, Frederick John.
Armstrong, George Kenneth.
Arnold, Arthur Geoffrey.
Avasthi, Raghuvansh Lall.
Barks, Donald Tinsley.
Baumann, Reginald George.
Bennett, Douglas Geoffrey.

Students—continued

Bennett, Herbert Ernest.
Binge, Derick Victor.
Black, Gordon Arthur.
Blake, Reginald Cyril S.
Blunt, Wilfrid Hallas.
Bodden, John.
Bolt, Stuart Blinston.
Brink, Martinus Beyers.
Brown, Geoffrey William.
Bryant, James Francis M.
Burrows, Geoffrey Harold.
Chakravarti, Krishan C.
Chapman, John.
Chatterjee, Tapa Prasad, B.Sc.
Choudhary, Hari Swarup.
Chugg, Morley Incledon.
Clarke, John Hughill S.
Clater, John William, Sec. Lieut.
Crocker, Alan.
Crofts, John.
Da Costa, Albert Armit H.
Davin, Kenneth.
Dilworth, James William.
Dinsdale, Ernest.
Duckworth, Henry Allen G.
Duncombe, Leonard.
Eades, Angus Bonar.
Elstone, Frederick Charles.
Farrow, Colin Pyewell.
Fenlon, Albert.
Fonseca, Oswald James.
France, George.
French, Eric Lionel.
Gallia, George William D.
Germany, Leslie Walter.
Ghose, Hiran Kumar.
Graham, Isaac Jonathan.
Groves, Dennis Keith.
Gupta, Qabul Chand, M.A.
Gyani, S. Devindar.
Hainsworth, Joseph Richard.
Haldipur, Dinakar Santaya.
Harling, Ernest George.
Harvey, John Gordon N.
Heathcock, Neville Charles.
Hitchcock, William Joseph.
Horsfield, Brian Robert.
Hosken, Albert Frederick.
Humble, Thomas.
Hung, Ng Ngok.
Jayaswal, Yogendra Prasad, B.Sc.(Eng.).
Jones, William Percy.
Joseph, Kantharaj, B.Sc.
Kale, Siddhanath Dhondopant.
Kanagalingam, Suppiah.
Kapitan, Ratilal Ranchhod.
Karkal, Narsing Gopalkrishnarao.
Khatib, Mohomed Husein M. H.
Kirner, Francis Anthony.
Kor, Dilip Kumar.
Kulkarni, Hari Raoji.
Kumaraswamy, Kantappar.
Lal, Baldev Krishna.
Langnejia, Babubhai Lallubhai.
Leahy, William John.
Levey, Richard Charles L.
Lewis, Samuel Charles.
Libby, Lionel Clifford.
Lingwood, Norman Lionel G.
Lote, William Hayward.
Lucas, Donald Norman.
Mayall, John René.
Midha, M. L.
Miniovitch, Anatol Naftaly.
Miranda, Isidore Michael.
Modak, Vaman Ramchandra.
Mohideen, Mohamed Hasheem M.
Morgan, William Herbert.
Motiwalla, Minocher Framroze.
Naab, Peter George.
Nadkarni, Mangesh Vinayak.
Naik, Ramanlal Bhagvanji.
Nair, Chakkingal Krishnan.
Natarajan, G. A.
Norman, James Noel M.
Nuttall, Ralph Ellis G.
Parkinson, Harry Lester.
Patel, Manubhai Mangaldas.
Peel, Philip Henry.
Periyaswami, A.
Phillips, William.
Pickles, Jack.
Pincombe, Edward Francis.
Pounds, Kenneth Charles.
Powell, Richard Neville.
Pownall, Charles.
Prabhakaran, V. Krishna Panicker.
Rajahmoney, Amirthanayagam.
Ramachandran, Thiagarajan.
Ranikhetvala, Rustam.
Richards, Dermot Aefred.
Richardson, Allan Keith.
Richardson, Edward Albert.
Roy, Jibendra Lal.
Saldanha, Paul, B.Sc.
Sathe, Manohar Dinkar.
Sathiavagiswaran, J.
Scarr, William Theodore.
Sethi, Keshava Dev.
Seymour, Oliver.
Sharma, Parash Ram, B.Sc.
Shaukat, Sheikh Mohamed.
Shevade, Govind Vasudeo.
Simpson, John Collingwood.
Simpson, Robert Mortimer.
Singh, Nar Bahadur, B.A.
Sivaswamy, Chivukula.
Spence, Huntly Gordon.
Stansfield, Donald Heaton.
Stanway, Geoffrey Edmund.
Stephens, Evan Mervyn.
Suppiah, Arunasalam.
Tanwar, Atma Ram.
Taraporewala, Firoze Kaikushroo.
Taylor, Herbert Stanley.
Teago, Antony Charles.
Thakur, Rattan Singh.
Thorpe, Alfred.
Turner, Alexander Dickson.
Unvala, Hoshang Ardeshir, B.Sc.
Vernon, Hubert Sydney.
Vohra, Aliji Ismail.
Wainwright, John.
Walter, George Oscar.
Waylen, Ronald James.
Weaver, John James L.
Williams, Dewi Emrys.
Williams, Edward Kenneth.
Wilsdon, Guy Charles H.
Wilson, Douglas Edward R.
Wilson, John Cecil.
Yennemadi, Gopalkrishna Devrao.

Transfers

Associate Member to Member

Bamber, Leonard John.
Campbell, Harold Gordon, B.Sc.
Clarke, Arthur Edward.
Cole, Frank Jasper.
Forster, William Johnston.
Frost, Thomas George.
Huff, Walter Cyril, Lieut.-Colonel.
King, Arthur John, B.Sc.Tech.
Manighetti, Augustus.
Montgomery, Alexander William, B.Sc.Tech.
Mullens, Harold Hill, B.Sc.
Parkinson, Arthur Muir, B.Sc.(Eng.).
Rao, Pappu Subba, B.A.
Smale, John Arthur, B.Sc.

Associate to Asssociate Member

Harling, Sydney Cyril.
Kilner, William Norman.
Marsh, Arthur.
Matthews, Francis Albert.
Semmens, Ernest William.
Stewart, Edward Osmun.
Sundar, Padma Malla, B.Sc.

Graduate to Associate Member

Akers, Bernard Horace.
Andrews, William Thomas.
Arnold, Arthur Newton.
Anscombe, Hedley Jesse E., B.Sc.
Baird, Trevor Gordon.
Baker, Alan William, B.A.
Balean, Henry Hamilton, Elec. Lieut., R.N.V.R.
Batho, Ernest William.
Beard, Harold Jenner, B.A.
Beard, Robert James.
Birks, Kenneth William.
Booth, Eric Stuart, M.Eng.
Bray, Philip Robert, M.Sc.(Eng.).
Brown, Harold Godfrey.
Burrell, Maurice Barnard F.
Cherry, Edward Colin, M.Sc.(Eng.).
Clark, Francis James, B.Sc.
Clark, Stuart Vincent E.
Clegg, Frank.
Cornish, Reginald Edward.
Dietrichsen, Christian Frederick, B.A.
Doré, Claude Urling.
Douglas, Alfred George, B.Sc.
Earnshaw, William.
Fisher, Arthur John M., Captain.
Foss, George Henry, Squadron Leader, R.A.F., B.Sc.
Freeborn, Kenneth Lionel C., B.Sc.(Eng.).
Godbold, Brian Craig, B.Sc.
Grimes, Wilfred Wallace.
Guest, Brian Carwardine.
Gwyn, David Glanville, B.Sc.(Eng.).
Hales, Ronald Leslie.
Hart, Donald Alfred.
Hart, James Ernest.
Hemingway, Joseph Wilson.
Hitchcock, Henry Coleridge, B.E.
Honnor, Thomas Allwright D.
McDonald, George John, B.Sc.
Matthey, Henry Albert.
Mazumder, Sudhir Chandra B., B.Sc.
O'Hara, Kean William, B.Sc.(Eng.).
Palmer, Ernest Henry.
Parker, Joseph Donald, Lieut. Royal Signals, B.Sc.
Parker, William Frederick.
Pelton, Bruce Sydney, B.Sc.(Eng.).
Pickard, Laurence Herbert.
Piggott, Leslie Sylvester, M.Sc.(Eng.).
Preston, George Neil, Major, R.A.O.C.
Purden, Robert Hesketh.
Ralph, Tom.
Ramamurti, Krishnaswamy, M.A.
Sen, Ranajit Chandra, B.Sc.
Simmonds, Philip Ellis.
Sinha, Shiva Nandan P., B.Sc.(Eng.).
Sloane, Robert Wood, B.Sc., M.A., Ph.D.
Smith, George Ernest.
Tabb, Cecil Stanley.
Tabb, Richard Prestridge E., B.Sc.
Taylor, Cecil William.
Tuff, Lawrence Forbes.
Webb, Edward Francis D., B.Sc.
Whitehead, John.
Widdup, Francis Alan, B.Sc. Tech.
Williams, Kenneth Alfred.
Wood, Herbert Brian, B.Sc.
Worland, Frank James.
Yates, Peter Weston, B.Sc.

Student to Associate

Thiruvengadam, Mylapore.

In addition, the following transfers were effected by the Council at their meeting held on the 24th April, 1941:—

Student to Graduate

Battiwala, Behli Phirozeshah.
Bhakat, Bhabani Prosad.
Brown, William Henry.
Browne, Kenneth Francis K., B.Sc.(Eng.).
Buchanan, Norman Hamilton, B.Sc.
Chaudhary, Mohammed Bashir.
Coller, David Lonsdale, B.Sc. Eng.).

Student to Graduate—continued

Corbett, Jack Murray.
Coxon, Herbert William.
Cross, John Leonard.
Darukhanawala, Beheram Jehangirji.
Datta, Budh Dev.
Douthwaite, Brian Hugh.
Downes, John Godkin.
Fernando, Joseph Montagu.
Giri, K. Periyaswamy.
Gupta, Bibhuti Bhushan.
Halliday, Kenneth William J.
Hamilton, James, B.Eng.
Hawkins, Cyril George, B.Sc.(Eng.).
Honess, Leslie George, B.Eng.
Hudson, John, B.Eng.
Husain, S. Nasir, B.Sc.
Husein, Amir Ebrahim.
Isherwood, Charles Medcalf, B.Eng.
Iyer, S. Mahadeva.
Jones, Donald William K., B.Sc.(Eng.).
Kanwar, Dalip Singh.
Karaosman, Mahmut Naim, B.Sc.
Kennedy, Graham, B.Sc.
Kesari, S.
Kingravi, Iftikhar Ahmad.
Langford, Robert, B.Sc.(Eng.).
Makin, Neil Meredith, B.Sc.
Maleksirat, Hassan.
Mathiesen, Eric.
Milner, Peter Marshall, B.Sc.(Eng.).
Munro, Hugh Alexander.
Nadkarni Prabhakar Shankarrao.
Narayanaiyer, P. I.
Osmond, George Cecil.
Parker, John Reginald.
Patel, Framroze Bomanji.
Patel, Rambhai Purushottamdas.
Probert, Howard John.
Prout, Donald Cornell, B.Sc.(Eng.), Sub-Lieut., R.N.V.R.
Purchase, Harry Zander.
Ramarao, Mysore Venkatasubbarao.
Rawling, Robert Sydney, B.Sc.
Richmond, Joseph Raymond W., B.Sc.(Eng.), Sub-Lieut., R.N.V.R.
Rikhy, Amolak Singh.
Robertson, Ronald Hislop.
Sadiq, Syed Abdul.
Sankaranarayanan, P. A.
Sanmugaraja, Nadaraja.
Schofield, Cyril James, B.Sc. Tech.
Semmelink, Adelbert.
Shroff, Adi Kaikhusroo.
Simmons, James Douglas, B.Sc.(Eng.).
Singh, Harbans.
Sleigh, Arthur Ffennell C., B.Sc.(Eng.).
Soloman, Aaron.
Southgate, Herbert William.
Taberner, James Walter.
Taylor, Wilfred.
Taylor-Cannon, Lewis George.
Teicher, Ludwik, B.Sc.
Turner, John Douglas H., B.Sc.(Eng.).
Vadgaokar, Manohar Ganpatrao.
Vick, Alfred Spencer.
Wells, David Woodward, B.Sc.(Eng.).
Widdicombe, Eric John.
Wilkinson, John Granville G.
Wilson, Graham Rudge, B.Sc.(Eng.).
Wootton, Douglas Jaques, B.Sc.(Eng.).

ACCESSIONS TO THE LIBRARY

[NOTE.—(*) denotes that the book is also in the Lending Library. The books cannot be purchased at The Institution: the names of the publishers and the prices are given only for the convenience of members.]

SMYTHE, W. R. Static and dynamic electricity. 8vo. xviii + 560 pp. (New York; London: McGraw-Hill Publishing Co., Ltd., 1939.) 40*s*. (*)

Written for the experimental research physicist and engineer rather than for the theoretical man. The reader should be familiar with vector analysis, the calculus, and elementary differential equations.

SPRING, H. M. Boiler operator's guide. Construction, operation, inspection and maintenance of steam boilers. 8vo. xi + 353 pp. (New York; London: McGraw-Hill Book Co., Inc., 1940.) 21*s*. (*)

The volume contains many examination questions and answers.

SQUIRE, E. M. Introducing radio receiver servicing. A primer for radio service engineers, radio mechanics, testers, etc. sm. 8vo. vii + 100 pp. (London: Sir Isaac Pitman and Sons, Ltd., 1940. 6*s*. (*)

STEWART, R. W., *D.Sc.*, and SATTERLY, J., *D.Sc.*, *M.A.* Textbook of heat. 2nd ed., revised by C. T. Archer. 8vo. vii + 410 pp. (London: University Tutorial Press, Ltd., 1939.) 7*s*. 6*d*.

A comprehensive course on the theory of heat, mainly of Intermediate University standard.

STEWART, R. W., *D.Sc.*, and SATTERLY, J., *D.Sc.*, *M.A.* Textbook of light. 7th ed., revised by C. T. Archer. 8vo. vii + 365 pp. (London: University Tutorial Press Ltd., 1941.) 7*s.* 6*d.*

Intended primarily for the use of students preparing for the Intermediate examinations in Science and Engineering of the University of London.

STUBBINGS, G. W. Electrical technology for beginners. A simple non-mathematical textbook on the supply and utilisation of electricity. sm. 8vo. vii + 156 pp. (London: E. and F. N. Spon, Ltd., 1940.) 5*s.* (*)

—— Electrical testing for practical engineers. A handbook of reference for engineers engaged in the erection and maintenance of electrical installations, plant and machinery. sm. 8vo. vii + 252 pp. (London: E. and F. N. Spon, Ltd., 1939.) 8*s.* 6*d.* (*)

—— Power factor problems in electricity supply. An elementary treatise for students, supply engineers and power users. sm. 8vo. vii + 174 pp. (London: E. and F. N. Spon, Ltd., 1940.) 8*s.* 6*d.* (*)

THOMPSON, M. DE K. Theoretical and applied electrochemistry. 3rd ed. 8vo. xxi + 535 pp. (New York: The Macmillan Co., 1939.) 22*s.*

Entirely rewritten in order to bring it up to date. The work is divided as follows: part I, Theoretical; part II, Applied electrochemistry of aqueous solutions; part III, Electric furnaces and their products.

TUPLIN, W. A., *D.Sc.* Vibration in machinery. An introduction to general principles. sm. 8vo. viii + 111 pp. (London: Sir Isaac Pitman and Sons, Ltd., 1940.) 7*s.* 6*d.*

Intended to give a general review of fundamental principles with the minimum of mathematical complication and to form an introduction to the more highly technical works on vibration theory.

WARREN, A. G., *M.Sc.* Mathematics applied to electrical engineering. With a foreword by A. Russell. 8vo. xv + 384 pp. (London: Chapman and Hall, Ltd., 1939.) 15*s.* (*)

The majority of problems arising in electrical practice and research call for a ready facility in the application of mathematics of a comparatively modest standard. It is mathematics of this nature with which the author is chiefly concerned.

WATSON, H. M., WELCH, H. E., and EBY, G. S. Understanding radio. A guide to practical operation and theory. 8vo. ix + 603 pp. (New York; London: McGraw-Hill Publishing Co., Ltd., 1940.) 20*s.* (*)

An elementary non-mathematical treatise with chapters on short-wave and ultra-short-wave sets.

WHITEHEAD, A. C. Planning, estimating and ratefixing for production engineers and students. 3rd ed. ix + 310 pp. (London: Sir Isaac Pitman and Sons, Ltd., 1939.) 12*s.* 6*d.* (*)

WILD, E. E. Transformers. 8vo. 132 pp. (London: Blackie and Son, Ltd., 1940.) 5*s.*

The author has endeavoured to cover briefly the theory, design and operation of transformers and the general standard is that of an engineering degree.

WILSON, W., *D.Sc.* The calculation and design of electrical apparatus. 2nd ed. sm. 8vo. xiii + 230 pp. (London: Chapman and Hall, Ltd., 1940.) 10*s.* 6*d.* (*)

This book describes the principles upon which the complete design of switchgear, control gear, protective equipment, instruments, and similar apparatus is based. It is intended to assist candidates who take this subject in the I.E.E. Examination, also university and technical college students and designers in the manufacturing industry. For nearly every formula given fully worked-out examples have been provided.

WILSON, W., *F.R.S.* Theoretical physics. vol. 2, 3. 8vo. (London: Methuen and Co., Ltd., 1933–1940.)

vol. 2, Electromagnetism and optics, Maxwell–Lorentz. xi + 315 pp. 20*s.*

vol. 3, Relativity and quantum dynamics, Einstein–Plan. x + 276 pp. 21*s.*

WINDRED, G. Electrical contacts. 8vo. xii + 403 pp. (London: Macmillan and Co., Ltd., 1940.) 16*s.* (*)

An account of the theory and applications of electrical contacts for design and research engineers. Arc and circuit phenomena, arc discharge and suppression are subjects included in the work.

WITTS, A. T. Radio upkeep and repair for amateurs. 4th ed. ix + 215 pp. (London: Sir Isaac Pitman and Sons, Ltd., 1940.) 6*s.* (*)

—— The superheterodyne receiver. Its development, theory and modern practice. 4th ed. sm. 8vo. vii + 189 pp. (London: Sir Isaac Pitman and Sons, Ltd., 1939.) 4*s.* (*)

WOOD, A., *M.A.*, *D.Sc.* Acoustics. 8vo. xvi + 588 pp. (London: Blackie and Son, Ltd., 1940.) 27*s.* 6*d.* (*)

A textbook for honours students. While the classical side is not overlooked, the modern extensions of the subject, such as ultrasonics and developments in sound recording and reproduction are included.

WORLD POWER CONFERENCE. Vienna Sectional Meeting, 1938. Transactions. 7 vol. 8vo. (Berlin: VDI-Verlag; London: Percy Lund Humphries and Co., Ltd., 1939.)

WYBROW, S. G. Electrical and wireless equipment of aircraft, including the repair, overhaul and testing of magnetos. ("X" licence.) 4th ed. 8vo. viii + 181 pp. (London: Sir Isaac Pitman and Sons, Ltd., 1940.) 5*s.*

YULE, G. V., *M.A.*, *F.R.S.*, and KENDALL, M. G., *M.A.* An introduction to the theory of statistics. 11th ed. 8vo. xiii + 570 pp. (London: C. Griffin and Co., Ltd., 1937.) 21*s.*

The most important changes in this edition are additional chapters on sampling, moments and measures of skewness and kurtosis, and on simple curve fitting by the method of least squares.

ZWORYKIN, V. K., *Ph.D.*, and MORTON, G. A., *Ph.D.* Television: the electronics of image transmission. 8vo. xi + 646 pp. (New York; John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1940.) 36*s.* (*)

The book is divided into four main parts as follows: 1, Fundamental physical principles; 2, Principles of television; 3, Component elements of an electronic television system; 4, RCA-NBC television project.

REPORT OF THE COUNCIL FOR THE YEAR 1940–1941, PRESENTED AT THE ANNUAL GENERAL MEETING OF THE 8TH MAY, 1941

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REPORT

The Council, at the Sixty-Ninth Annual General Meeting of The Institution, present to the members their Report for the year 1940–41, covering the period from the 1st April, 1940, to the 31st March, 1941. The Council desire once more to express the Institution's warmest thanks to its many members who have continued, by service on Committees, by contributing papers and in other ways to give their time and attention to the promotion of the Institution's work and activities. The assistance they have given has not only contributed to the general readjustment that has become necessary as a result of the war, but has been of direct value in helping to ensure that The Institution as a body should make its full contribution within the terms of its Royal Charter to the common cause. At the same time the Council are fully conscious of the great part that is being played by members individually in the many fields, industrial and otherwise, which go to make up the contribution of electrical engineering in the national effort, and especially the direct services that are being rendered by the many hundreds of members who are in the technical units of His Majesty's Forces.

For the greater part of the year London has been subjected to air attack, and the Council wish to record their appreciation of the work of the Secretary and his staff who have efficiently carried on their duties under difficult conditions. Even during the period of intensive day bombing they unanimously elected not to transfer to the emergency accommodation which had been provided, as they felt this would impair the important work in which The Institution is engaged.

(1) MEMBERSHIP OF THE INSTITUTION

The changes in the membership since the 1st April, 1940, are shown in Appendix A, and the net growth of membership for the last 15 years will be found in Appendix B. With regard to the latter, it is of interest to note that during the course of this period the total membership has increased by 7 626, which compares with an increase of 6 110 for the preceding 15 years. As the number of members on the register at the commencement of that period, i.e. in 1912, was 6 537, it will be seen that in the last 30 years the membership has been more than trebled. A satisfactory feature of the more recent situation is the fact that whilst during the first three years of the last war the membership dropped by 432, there was an increase of 528 for the session 1939–40 and one of 403 for the present session. These compare with an average increase of 665 for the five years preceding the present war. The number of Corporate Members of The Institution is now 10 121. An appreciable number of Associate Members have transferred to the class of Members during the year, but it is clear from an examination of the list of Associate

Members that there remain in that class many who are qualified for the higher class. The Council urge these members to apply for transfer with a view to taking their proper place in the membership of The Institution.

(2) HONORARY MEMBER

The Council have pleasure in recording that, as announced at the Ordinary Meeting on the 30th January, 1941, they have elected The Rt. Hon. Sir Andrew Rae Duncan, G.B.E., to be an Honorary Member of The Institution.

(3) FARADAY MEDAL

The nineteenth award of the Faraday Medal has been made by the Council to Dr. A. P. M. Fleming, C.B.E., M.Sc. (Past-President).

(4) HONOURS AND DISTINCTIONS CONFERRED ON MEMBERS

C.B.

Pringle, James Scott, O.B.E. (Member).
Watson Watt, Robert A., B.Sc.(Eng,) (Member).

C.B.E.

Fuller, Major-General Algernon Clement, O.B.E., Royal Signals (Associate Member).
Sykes, Colonel Arthur Clifton, O.B.E., D.S.O. (Associate Member).
Webb, John (Associate Member).

O.B.E.

Bennett, Major Maurice Chesterton, Royal Signals (Associate Member).
Brazier, Lt.-Col. Clifford Claude H., M.B.E., R.E. (Associate Member).
Harbottle, Horace Reginald, B.Sc.(Eng.) (Member).
Leeson, Colonel Bruce Hamer, T.D., R.E. (Member).

M.B.E.

Cook, Alfred George (Associate Member).
Daw, Sydney Ernest H. (Associate).
Redclift, Stanley Whitlock (Member).

D.S.O.

Kennedy, Lieut.-Col. John Ross, B.Sc., R.E. (Associate Member).
Mountbatten, Captain The Rt. Hon. Lord Louis, G.C.V.O., R.N. (Associate Member).

George Cross.

Ryan, Lt.-Comdr. Richard John H., R.N. (Associate Member) (Posthumous Award. Killed in Action).

D.F.C.

Gore, Flying-Officer William Ernest, B.Sc.(Eng.), R.A.F. (Graduate).

M.C.

Metson, Lieut. Gilbert Harold, B.Sc.(Eng.), Royal Signals (Associate Member).
Wood, Major Peard Thornton, R.E. (Associate Member).

George Medal.

Duncan, Sub-Lieut. Ronald Andrew, B.Sc., R.N.V.R. (Graduate).
Griffiths, Gilbert John (Associate Member).
Little, Gilbert Joseph S., B.Sc. (Member).
Whelton, George Herbert (Associate).

Mentioned in Despatches.

Ball, Sub-Lieut. Charles Edward, R.N.V.R. (Student).
Furnell, Lieut. Percy Gawayne, R.N.V.R. (Associate Member).
Mountbatten, The Rt. Hon. Lord Louis, G.C.V.O., R.N. (Associate Member).
Rendle, Sub-Lieut. Harold Barton, R.N.V.R. (Associate Member).
Stewart, Lieut. Alan Chambers, R.N.V.R. (Student).
Stott, Captain John, B.Sc.Tech., R.A.S.C. (Graduate).

(5) ROLL OF HONOUR

It is with regret that the Council have to record the loss of the following members during the past 12 months of the war:—

Killed in Action.

Adye, A. F. C., Major, R.A. (Associate Member).
Ainley, P. E., B.A., Lieutenant, R.A.O.C. (Associate Member).
Brooks, H. W., Lieutenant, R.N.V.R. (Graduate).
Collins, F. H., B.Sc.Tech., Sub-Lieutenant (E), R.N.V.R. (Graduate).
Edgcumbe, P. R., Second Lieutenant, 12th Lancers (Graduate).
Hampton, D. A., Sergeant, R.A.F. (Graduate).
McKee, J., Sergeant, R.A.F. (Student).
Ord, C. B., Sub-Lieutenant, R.N.V.R (Student).
Powell, G., Lance-Sergeant, Royal Signals, (Student).
Pyman, L. L., B.A., Pilot Officer, R.A.F. (Student).
Ryan, R. J. H., Lieutenant-Commander, R.N. (Associate Member).
Stockton, D. A., Sergeant, R.A.F. (Graduate).
Tozer, J. J., Pilot Officer, R.A.F. (Student).
Tuck, W. D., B.Sc.(Eng.), Lieutenant, R.A. (Associate Member).

Killed on Active Service.

Adam, D., Lieutenant, R.E. (Associate).
Armstrong, A., Acting Leading Naval Airman, Fleet Air Arm (Student).
Furse, C. W., B.A., Flying Officer, R.A.F. (Graduate).
Gates, R. E., Signalman, Royal Signals (Graduate).
McVicar, J., B.Sc., Major, R.A.O.C. (Associate Member).
Prout, R. W., Sergeant, R.N.Z.A.F. (Student).
Raymond, I. V., Mechanist Sergeant-Major, R.E. (Graduate).

Died of Wounds.

Brigstocke, W. G. P., Lieutenant, R.N.V.R. (Graduate).
Rothwell, H. K., Signalman, Royal Signals (Student).

Died on Active Service.

Brewis, J. M., Lieutenant-Colonel, M.C., R.A.O.C. (Associate Member).
Kerr, J. V., Signalman, Royal Signals (Student).
McNeal, G. A., Second Lieutenant, Royal Signals (Graduate).

Killed by Enemy Action.

Adamson, O. H., B.Sc.Tech. (Associate Member).
Allen, N. A., Ph.D., M.Sc.(Eng.) (Associate Member).
Brown, W. F. (Associate Member).
Merz, C. H., D.Sc. (Member).
Merz, R. de S., B.A. (Graduate).

It is with great regret that the Council record above the loss of a Faraday Medallist and past Vice-President, Dr. Charles H. Merz. His outstanding abilities will be sadly missed in the country's war effort and during the period of reconstruction after the war.

The Institution has also lost the following members of its staff:—

Killed in Action.—Blanchard, E. A., Troop Sergt.-Major, Royal Artillery.
Killed by Enemy Action.—Leveridge, Miss M.

(6) DEATHS

The Council also regret to have to record the deaths of the following members of The Institution during the year:—

Honorary Members.

Lodge, Sir Oliver, D.Sc., F.R.S.
Smith, Roger T., B.Sc.
Thomson, Sir J. J., O.M., M.A., F.R.S.

Members.

Anslow, F.
Archer, R. M.
Barrs, E.
Bell, Major H., O.B.E., T.D.
Clarke, Captain J.
Cruickshank, W.
Culbertson, Dr. J. N.
Denehy, H.
Dickinson, A.
Edwards, F. H.
Esson, W. B.
Evans, F. J.
Fleming, T. J.
Gittins, G. E., B.Sc.
Hadfield, F. H.
Hadfield, Sir Robert A., Bart., F.R.S.
Hards, L. A.
Heather, Professor H. J. S.
Jenkin, Professor C. F., C.B.E., M.A.
Jones, S. D.
Kennard, F. E., M.A., B.Sc.
Knight, J. D.
Levin, Major A. E., T.D.
Mackenzie, I. S.
McMahon, P. V.
Makower, A. J., M.A.
Massey, W. H., M.V.O.
Monkhouse, E. W., M.V.O.
Nicholson, J. H.
Nisbett, G. H.
Oliver, C.
Parsons, I. H.
Partridge, G. W.
Paxton, D. S.
Pember, J. D.
Phillips, A. D.
Proctor, C. F.
Robertson, Prof. D., D.Sc.
Roles, T.
Sarsfield, L. G. H., D.Sc. (Eng.).
Schuster, L. W., M.A.
Shaw, A. H.
Sorenson, S. S.
Sparks, C. P., C.B.E.
Stanley, F. E.
Stobie, V.
Stroud, Prof. H., D.Sc.
Sumpner, W. E., D.Sc.
Tandy, F.
Tonge, J. H.
Tremain, F.
Tubini, B. A.
Tucker, A. G.
Walker, Prof. Miles, M.A., D.Sc., F.R.S.
Willans, P. W., M.A.
Willis, R. W.
Wilson, L. E.
Woodhouse, W. B.
Yeaman, C. H.

Associate Members.

Barnes, S. P.
Buckton, W. W.
Chamier, Captain W., R.M.E.
Clarke, W. W., B.Sc.(Eng.).
Coventon, G. L.
Coward, A. C.
Crisp, M. H. T.
Crowson, G. A.
Croxford, M. P., B.Sc.
Dixon, A. C.
Duff, W. A., M.A.
Edwards, W. S.
Fishenden, E. G.
Fisher, F. L., M.B.E.
Freemantle, W. H.
French, A. E.
Greig, A.
Hall, A.
Hodge, T.
Hussain, K. M., M.A.
Innes, W.
Jones, R.
Khanna, J. P.
King, H. R., B.Sc.(Eng.).
Kouyoumdjian, V. T., B.Sc. (Eng.).
Lunn, P.
Martin, P. M.
Morgan, C. F. J., M.Sc.
Murphy, F. M. G., M.A.
Naftel, P. H.
Nash, H.
Nicol, E. W. L.
Orr, A. J.
Parker, H. C., M.B.E.
Pealing, J. A. L.
Pennell, E. R.
Prowse, R. M.
Quilliam, L., B.Sc.Tech.
Radford, J. S.
Robinson, S. T.
Rolph, W. M.
Shankster, G. C.
Shannon, J. H.
Shorter, T. E.
Shoults, E. S.
Sims, A. H.
Skinner, E. J., M.B.E.
Somerville, G. W.
Stephen, F. V.
Teal, S. G. M.
Thomas, E. O. P.
Todd, H. E.
Warburton, F. G.
Wylie, T. O. K.
Yapp, P. A.

Companions.

Fraser, K.
Merriman, W. H.
Rowell, P. F.
Sandberg, O. F. A., O.B.E.

Associates.

Bickerton, H.
Lacey, E. W.
Lanceley, C.
Mackinnon, L.
Moore, E. J. T.
Pritchett, T. W.
Roughton, E. A.
Savill, A. G.
Shields, J. C.
Sims, P. J.
Tamblyn-Watts, T. M. F.
Tutt, F. H

Graduates.

Andrews, A.
Arbour, W. F.
Banerji, S. K.
Boardman, A. E.
Drake, S. R., B.Sc.
Heyes, O., B.Sc.
Parker, A. G.
Ramanathan, P., B.A.
Stewart, G. S.
Stock, L. G., B.Sc.

Students.

Crozier, I. V. C.
Duncan, L. A.
Easton, H. I.
Gordon, D. M.
Howells, M. P.
Parkhurst, J. W. E.
Procter, F. L.
Scott, A. H. E.
Stewart, D.
Willson, L. R.

The Council have recorded above with profound regret the deaths of Mr. Roger T. Smith (Honorary Member), Mr. C. P. Sparks, C.B.E., and Mr. W. B. Woodhouse, all Past-Presidents of The Institution, and it is desired to take this opportunity of paying tribute to the great work which they did throughout their careers, not only for The Institution but in their respective spheres for the industry generally.

The Institution has sustained further serious loss resulting from the deaths of such eminent scientists as Sir Oliver Lodge, D.Sc., F.R.S. (Past Vice-President) and Sir J. J. Thomson, O.M., M.A., F.R.S., both Faraday Medallists and Honorary Members. The outstanding achievements of these distinguished members contributed in no small measure to the great and rapid progress which has been made in electrical science during the lifetime of the generation to which they belonged.

(7) INSTITUTION MEETINGS

In September last the Emergency Committee, set up in the previous session, met to consider the question of the Institution's activities during the first half of the approaching session, for which, with the approval of the Council, the Papers Committee had already made provisional arrangements for the holding of monthly Ordinary Meetings for the reading and discussion of papers. It was reluctantly decided by the Emergency Committee that, in view of the change in the situation, it would not be practicable to proceed with the customary programmes of evening meetings in London and that all that could be contemplated was one afternoon meeting at which the Inaugural Address of the President should be delivered.

As an alternative to the usual meetings, the procedure adopted in the first half of the previous session was followed and members were invited to apply for advance copies of papers that had been allocated for reading, with a view to the submission of written comments for publication in the *Journal* as discussion, with the author's reply, when the paper itself appeared. With regard to the activities of the Local Centres and Sub-Centres, it was again left to the various local Committees to decide for themselves the best course to follow, having regard to the conditions prevailing in their respective areas.

In December the Council again decided, on the recommendation of the Emergency Committee, that it would be inadvisable to hold regular meetings in London during the second half of the session. Details of the papers of which advance copies could be obtained were accordingly issued to members with the January number of the *Journal.*

Members were at the same time advised of the Council's proposal to hold an Ordinary Meeting, circumstances permitting, for the delivery of the Kelvin Lecture on the afternoon of the 8th May, 1941, which was also the day decided upon for this Annual General Meeting.

Apart from questions affecting the regular activities of The Institution, it has been necessary for attention to be directed by the Council and its Committees to a number of important matters in connection with the electrical engineering aspect of the war effort. Details of such matters are given in other parts of this Report.

(8) NATIONAL SERVICE

Throughout the year The Institution has continued to co-operate closely with the Ministry of Labour and National Service in the working of the Electrical Section of the Central Register of National Service. The task of directing the transition of the electrical technical man-power of the country in an orderly manner from peace to war is one to which the Council attach great importance; every effort is therefore being made to ensure that electrical engineers are employed in the war effort to the full extent of their technical capacity. In the course of this work a number of discussions and negotiations have arisen on matters which, while not directly connected with the Central Register, must have a bearing on its operation or on the wider problems involved. Among those matters mention may be made of the formulation of special plans for training young engineers to fill vacancies in certain categories in which there is a shortage of suitable candidates, the various adjustments necessary from time to time in the Schedule of Reserved Occupations and the employment of engineers in official appointments above the former maximum age limit of fifty-five.

There is still considerable doubt whether the fullest possible use is yet made of the Central Register by all the authorities entitled to use it; nevertheless, even under these conditions it serves a purpose which possibly was not directly foreseen in providing authoritative information to show in which branches of the profession there is an inadequate supply of personnel coming forward, thus enabling plans to be prepared at an earlier date than would be possible if the demands were not co-ordinated.

At the request of the Ministry of Labour, members of The Institution, except Companions and Students, who were residing in Great Britain and Northern Ireland were again invited in June, 1940, to enrol on the Central Register. The number of members eligible for enrolment was 12 500 and it is satisfactory to record that practically all those not previously enrolled were registered. Subsequently in the following month an Order was made by the Minister for the compulsory registration of all engineers, but at this stage the form of record card completed by the individual differed from that used by The Institution.

The placing panels of the Electrical Engineering Sub-Committee have met frequently and regularly since the outbreak of war, and the Council wish to record their appreciation of the close attention to detail and the time which has been given during the past year by the four members who have constituted the regular panel. The work thrown on them and on the staff has been very considerable.

(9) MILITARY SERVICE

Enlistment.

An arrangement is in operation with the Ministry of Labour to ensure that members who are liable for military service are posted to technical branches of the Forces. In order to effect this procedure, statements of membership have been supplied to members for the information of Placing Officers. Except in a very few instances, the arrangement has been entirely successful.

In the many and varied questions relating to the appropriate employment of electrical engineers in the national effort The Institution maintains close contact with the authorities concerned.

Age-Limit Students.

The Council are anxious to avoid a break in membership owing to Students joining His Majesty's Forces, and they have therefore allowed such Students to extend the period during which they can remain in that class by a period equal to the length of their war service with the Forces.

Postponement of Military Service.

As a result of representations made by The Institution and The Institution of Mechanical Engineers, the Minister of Labour and National Service agreed to provide in the Schedule of Reserved Occupations for the postponement of service in His Majesty's Forces of engineering apprentices or learners, provided that they were within two years of the satisfactory completion of a course of study for an engineering degree, the Higher National Certificate, or an examination of similar standing.

Members serving with His Majesty's Forces.

Lists are published in Institution Notes in the *Journal* from time to time of members serving with the Forces, and these lists already include the names of 1 663 members of all classes who are known to be serving, although there are no doubt others who have not yet sent the necessary information to the Secretary to enable their names, unit and rank to be included. This is a very high proportion of the membership, having regard to the great demands of industry upon the profession.

Members have not gone through the past year without loss, and the Roll of Honour records the names—set out in paragraph (5)—of 26 members who have made the supreme sacrifice while serving with the Forces.

Mention must be made here of the Secretary's staff, of whom 11 have been called to the colours. Of these, one —an assistant librarian—lost his life while assisting his men off the beaches of Dunkirk. The Secretary's personal secretary was killed by enemy action.

Although the authorities recognize that it is important that electrical engineers should be employed only in technical branches of the Forces, it was found that in a number of instances members had been posted to units where their qualifications were not being used. Representations have been made by The Institution to the appropriate Departments of the Services, and it is gratifying to note that in almost every instance transfers to technical branches have been effected.

(10) TECHNICAL EDUCATION FOR MEN IN HIS MAJESTY'S FORCES

At the request of the Service Departments The Institution agreed to co-operate with the Board of Education and the Institutions of Civil and Mechanical Engineers in formulating a scheme for the promotion of vocational technical education for men in His Majesty's Forces, so that they can continue their studies while temporarily serving in the Forces.

Special syllabuses were drawn up by educational experts to form a basis of instruction in the subjects of the Associate Membership Examinations of the three Institutions, and the scheme, which is conducted by the War Office with the assistance of officers seconded from the Board of Education, is now in operation and provides for tuition in these subjects, by correspondence or guided reading through the medium of panels of tutors.

Up to the present time over 2 000 applications have been received by the War Office from men in the Army and the Royal Air Force for tuition in the various engineering courses.

(11) CO-OPERATION WITH HIS MAJESTY'S GOVERNMENT

It was mentioned in the last Report that a letter was sent on behalf of the Council in November, 1939, to the three Defence Services and to the Ministry of Supply advising them that The Institution was continuing to function as far as possible in the normal way, and offering to give them any assistance or information which might be needed from time to time.

With the approval of the Emergency Committee the signature of the President was appended to a joint letter dated 31st May, 1940, from the Presidents of the Institutions of Civil, Mechanical and Electrical Engineers, to the Prime Minister offering to give any assistance in their power to His Majesty's Government in any emergency that might arise, to which an appreciative reply was received.

(12) ENGINEERING ADVISORY COMMITTEE

The Council feel sure that the recent announcement—foreshadowed by Lord Hankey in the House of Lords debate on the 2nd April, 1941—that the Government has decided to set up an Engineering Advisory Committee to advise upon engineering questions in connection with the war effort, will have been received by members with the greatest interest, as will the precise terms of reference set out in full in the official statement. When, as far back as October last, the Government set up a Scientific Advisory Committee with a view to ensuring the utmost use of science and scientists in the prosecution of the war, the Council viewed with concern the fact that the field of applied science was not represented on that Committee. As a result of the initiative of the Council this view was put before the Engineering Joint Council and was strongly supported by the other constituent Institutions. Arising from these discussions a letter signed by the Presidents of the eight engineering Institutions constituting the Engineering Joint Council was addressed to the Prime Minister, stressing the vital importance of engineering in the war effort and the desirability of appointing an Engineering Advisory Committee to co-ordinate it. It is, therefore, a matter for gratification that the Government has accepted the suggestion of the engineering Institutions and, in so doing, has given evidence of its recognition of the vital importance of engineering in the prosecution of the war.

(13) I.E.E. HOME SECURITY ADVISORY COMMITTEE

The Committee have continued to assist the Ministry of Home Security in electrical matters. They have considered various questions, including the electric heating of air-raid shelters, which has been dealt with in the A.R.P. series of British Standard Specifications. The Council desire to draw attention to the Memorandum on "Fire-Detection Devices, with special reference to the Detection of Incendiary Bombs," which was drafted by the Committee and has been published in the February issue of Part I of the *Journal*. Reprints of the Memorandum can be obtained, price 6d. each, on application to the Secretary of The Institution. A Specification for one system of detection has already been issued by the British Standards Institution, and it will be followed in due course by Specifications for other systems.

(14) POST-WAR PLANNING

The Council have recently had under consideration the subject of advance planning in preparation for the many problems affecting electrical engineering which will no doubt arise after the war, and in reviewing this matter it has become clear that in certain branches of electrical engineering there are matters to which immediate attention could well be directed. An indication having been given by the Minister of Works and Buildings in the course of a statement in the House of Lords that the technical professions are to be consulted in connection with the formulation of the Government's reconstruction programme, the Council feel that this Institution, as the representative body for electrical engineers, should be ready to provide the necessary expert advice when this is requested. In the circumstances the Council have set up a Post-War Planning Committee to consider the whole matter in all its various aspects, subject to close observance of the restrictions necessarily imposed by the aims and objects of The Institution as laid down in the Royal Charter. This Committee, which consists of the President, the four immediate Past-Presidents, the four Vice-Presidents and the Honorary Treasurer, has been given power to appoint such Sub-Committees as it may consider necessary.

(15) UNAUTHORIZED USE OF MEMBERSHIP INITIALS

During the past year there have been further instances of the use, by unauthorized persons, of initials or descriptions implying that they were members of The Institution. It has been possible on each occasion to ensure the discontinuance of the practice by the person concerned without the necessity of taking legal action.

(16) EXAMINATIONS

Associate Membership Examinations were held for a total of 509 candidates in May and November, 1940, in

London, Belfast, Birmingham, Cardiff, Dublin, Glasgow, Loughborough, Manchester and Newcastle-on-Tyne, and also, in November only, in Argentina, Australia, Ceylon, Federated Malay States, India, Iran, New Zealand, Nigeria, Palestine, South Africa and H.M.S. *Port Quebec.*

Examinations in English only were also held in May and November, 1940, at various centres in Great Britain for 201 holders of National Certificates in Electrical Engineering.

In addition 25 theses, submitted by candidates who were permitted by the Council to do so as an alternative to sitting for the Associate Membership Examination, were examined. The Page Prize was awarded to Mr. H. G. Dennes for his thesis entitled "The Conversion of a 1 250-kVA Hydro-electric Plant to Semi-automatic Operation." This Prize is offered annually for the best paper or thesis submitted in lieu of the Examination, provided that one has been received of sufficient merit to justify an award.

(17) COMMON PRELIMINARY EXAMINATION

The Engineering Joint Examination Board, a body set up under the aegis of the Engineering Joint Council, has prepared a set of rules and syllabus of a Common Preliminary Examination for the purpose of examining, by means of tests in general education, such candidates for Studentship and other grades as the Institutions constituting the Joint Council may refer to it, the first of such examinations being held in April, 1941. The Council of The Institution co-operated in the preparation of these rules and syllabus, but decided that it would be impracticable to participate during the war in a scheme which would impose a preliminary examination on candidates for Studentship of The Institution.

(18) NATIONAL CERTIFICATES AND DIPLOMAS IN ELECTRICAL ENGINEERING

England and Wales.—In 1940 the Joint Committee, representing the Board of Education and The Institution, were associated with the final examinations of 230 courses at colleges and schools in England and Wales, approved in connection with the above certificates and diplomas.

The final examinations were held during the summer, and the number of awards was as follows:—

Ordinary Certificates	843
Ordinary Certificates endorsed	—
Higher Certificates	370
Higher Certificates endorsed	25
Ordinary Diplomas	33
Higher Diplomas	4
Total	1 275

Scotland.—In conjunction with the Scottish Education Department, The Institution was associated with 14 courses in Scotland during the year under review.

The final examinations were held during the summer, and the number of awards was as follows:—

Ordinary Certificates	29
Higher Certificates	14
Higher Certificates endorsed	1
Higher Diplomas	4
Total	48

(19) SCHOLARSHIPS

The following Scholarships were awarded by the Council during the session:—

Ferranti Scholarship
(Annual Value £250; tenable for 2 years). No award.

Duddell Scholarship
(Annual Value £150; tenable for 3 years.)
D. la W. W. King (Northampton Polytechnic).

Silvanus Thompson Scholarship
(Annual Value £100, plus tuition fees; tenable for 2 years, renewable in approved cases for a third year.)
1938 award to H. Darnell (Liverpool University)* renewed for a third year.

William Beedie Esson Scholarship
(Annual value £120; tenable for 2 years, renewable in approved cases for a third year.)
C. H. Bickerdike (London and North-Eastern Railway).

Swan Memorial Scholarship
(Value £120; tenable for 1 year.)
No award.

David Hughes Scholarship
(Value £100; tenable for 1 year.)
J. H. Nicoll (Merchant Venturers' Technical College, Bristol.)†

Salomons Scholarships
(Value £60; tenable for 1 year.)
H. H. Rosenbrook (University College, London).
(Value £40; tenable for 1 year.)
P. H. W. Whyman (University College, London.)

Paul Scholarship
(Annual Value £50; tenable for 2 years.)
No award.

Thorrowgood Scholarships
(Annual Value £12 10s. each; tenable for 2 years.)
R. J. Post (London Passenger Transport Board).
R. P. Gasson (Southern Railway).

War Thanksgiving Education and Research Fund (No. 1).
No grants awarded.

All the scholarships and grants mentioned above may be awarded annually, with the exception of the Paul and William Beedie Esson Scholarships, which are awarded in alternate years only. If, however, an award of either the Silvanus Thompson or the William Beedie Esson Scholarship is renewed for a third year, the next award is deferred for a year.

(20) MEMBERS WHO HAVE RETIRED OR WHO ARE OF LONG STANDING

The Council wish to remind members of the existence of a rule which has been in operation for some years and which enables Members and Associate Members who have retired from the profession and are still desirous of retaining their membership of The Institution to do so without payment of further subscriptions. The rule is as follows:—

> "Any Corporate Member who has reached the age of 60 and has retired from the practice of his profession or business, may apply to the Council to remit his future annual subscriptions, provided that his member-

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* At present on military service, scholarship being held in abeyance.

† At present on work of national importance, scholarship being held in abeyance.

ship of The Institution has been continuous for at least 25 years. If he desires to have the *Journal* he will receive Part I (General) on payment of 10s. 6d. per annum and the other Parts (II and III) will also be available to him at the special rate of 7s. 6d. per Part which is allowed to other members."

In addition to the foregoing, it should be noted that a further rule provides that as soon as a member of any class has completed 50 years of membership he will cease to be asked to pay any further subscriptions, regardless of whether he is still in remunerative employment. This rule operates automatically and the member qualifying need not make application to The Institution.

(21) PREMIUMS

The Premiums awarded by the Council for papers read at meetings or accepted for the *Journal* will be announced about the time of the Annual General Meeting.*

The Council have decided, on the recommendation of the Wireless Section Committee, that one of the £10 Premiums customarily awarded for the Section papers shall in future be named the "Ambrose Fleming Premium."

(22) MEETINGS

During the past 12 months 267 meetings have been held in London and at the Local Centres by the members, the Council and the various Committees. A detailed statement is given in Appendix C.

As mentioned elsewhere in this Report, no Ordinary Meetings have been held this session for the reading and discussion of papers.

The average attendance at the two meetings held in April, 1940, which is included in the period now under review, and at the meeting held in October for the delivery of the Presidential Address, was 193. The average attendance for the eight Ordinary Meetings held during the preceding 12 months was 256. Six purely formal Ordinary Meetings for the election and transfer of members have been held this session.

(23) LOCAL CENTRES AND SUB-CENTRES

It is satisfactory to report that some of the Local Committees have found it possible to maintain their activities, in some instances by holding the usual sessional programme, in others by arranging a skeleton programme. Unfortunately, such activities have not been found practicable in some areas, the Local Committees having been compelled, owing to prevailing conditions, to suspend their usual meetings. The Council, who fully appreciate the difficulties with which these Committees are faced, express the hope that more favourable conditions, enabling a resumption of activities, will not long be delayed.

Details of such Local Centre and Sub-Centre activities as have been carried out are contained in the Annual Reports presented to the local members. In addition, as a new feature, particulars of current activities are now published each month in "Institution Notes" in Part 1 of the *Journal*.

The Council wish to take this opportunity of expressing their gratification at the sustained efforts of the officers and committees of the Local Centres and Sub-Centres in helping to maintain the traditions of The Institution, despite the many burdens they are individually bearing in the war effort. The place taken by the Centres and Sub-Centres in the organization of The Institution is considered by the Council to be of the greatest possible importance.

The customary opportunities afforded by the social functions held each year in normal times at the Centres and Sub-Centres for visits to be made by the President and the Secretary have again, unfortunately, been considerably curtailed. The President, however, was much gratified by the renewed personal contacts made possible by his attendance, together with the Secretary, at functions and meetings held by the South Midland and Western Centres, and by the East Midland Sub-Centre. A similar opportunity has arisen for a visit in April to the North-Eastern Centre, with which Mr. Beard was so closely associated in earlier days. It is regretted that owing to the general circumstances, and their steadily increasing commitments arising from the war, it has not been found practicable for the Vice-Presidents to put into operation a schedule of visits to local meetings, etc., on the lines of the scheme established before the war. The value of these periodical visits is by no means being overlooked, and every effort will be made to take advantage of any opportunity that may arise at any time to combine a visit of this kind with a journey necessarily made in the course of other duties.

It is interesting to record here that the Scottish Centre was represented by its Chairman, Prof. S. Parker Smith, on the ad hoc Committee set up to arrange the celebrations held in Edinburgh on the 11th January, 1941, to commemorate the centenary of Alexander Bain's original patent for an electric clock system and his conception of a printing telegraph. During these celebrations, which were held under the auspices of the Edinburgh Electrical Society and the Scottish Royal Society of Arts, a plaque was unveiled on the wall of Bain's house in Edinburgh.

Members are reminded that local technical library facilities are available at Aberdeen, Birmingham, Dublin, Dundee, Liverpool, Edinburgh, Glasgow, Leeds, Loughborough, Manchester, Middlesbrough, Newcastle-on-Tyne, Portsmouth and Southampton. Full details of the arrangements for borrowing or referring to the books in these libraries can be obtained on application to the local Honorary Secretaries.

The Annual Meeting of the Honorary Secretaries of Local Centres and Sub-Centres for the discussion of matters of common interest in regard to local organization and administration has not yet been held this year, but the possibility of arranging a meeting before the session closes is under consideration.

(24) TECHNICAL SECTIONS

The membership of the three technical Sections is now as follows:—

Wireless Section	1 165
Meter and Instrument Section ..	763
Transmission Section	1 660

The supply of papers on wireless subjects has been good, notwithstanding the fact that radio engineers are fully engaged in the national effort, and if meetings of the Section had been held a full programme would have been possible. Three papers on meter and instrument subjects have been accepted during the year as suitable for discussion and one for publication in the *Journal* without being discussed. As regards papers on transmission subjects, three have been accepted for discussion and four others for publication in the *Journal*.

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* See page 207.

The Addresses of the Chairmen of the Wireless, Meter and Instrument and Transmission Sections appeared in the first issue of Part I (January, 1941), of the *Journal*.

It was mentioned in the last Annual Report that consideration had been given to a suggestion that an Installation and Utilization Section of The Institution be set up. There was a general feeling that such a Section would fill a definite place in the activities of The Institution, and a scheme for the setting up of the Section was well advanced at the outbreak of war. Prevailing conditions prevented the immediate inauguration of the proposed Section, but the groundwork which had already been prepared is now being reviewed with the object of the Section being formed and commencing its activities as soon as practicable.

(25) STUDENTS' SECTIONS

The membership of the nine Students' Sections at London, Birmingham, Bristol, Glasgow, Leeds, Liverpool, Manchester, Newcastle-on-Tyne and Sheffield, is in the aggregate 4 267, which includes 2 011 Graduates.

Wherever local conditions have permitted, programmes of meetings, visits to works and social functions have been arranged, although in many cases these have had to be on restricted lines. Details of such activities as were possible have been given from time to time in the *Students' Quarterly Journal*.

Owing to difficulties in running the Sections caused by the calling-up for military service of members of Committees, the Council decided in February, 1940, to alter their Rules for Students' Sections so as to allow Graduates who so desire to continue during the period of the war their membership of Students' Sections after the end of the year in which they attain the age of 28. So far 193 Graduates have taken advantage of this alteration.

It was decided that, having regard to the general conditions, the customary series of Students' Lectures should not be arranged this session. It is hoped, however, that it will be possible for these Lectures to be resumed next session, and provisional arrangements have been made for Lectures to be delivered, if circumstances permit, by Dr. D. S. Anderson of the Central Technical College, Birmingham, and Dr. W. G. Radley of the Post Office Research Station, Dollis Hill.

In line with other Institution publications, the *Students' Quarterly Journal* has also been reviewed in the light of the paper restrictions. In this instance the requirements have been met by a complete change of style, and the use of a two-column lay-out with a slightly smaller type has enabled that *Journal* to continue with almost the same quantity of matter in half its previous number of pages.

In place of the Section Notes a general discussion of the various activities is included in each issue, and the Who's Who feature has been temporarily suspended.

The practice of passing all papers to the editor immediately, without waiting until the end of the session, has proved helpful in maintaining the standard of the publication, but it is encouraging to note that articles written specially for the *Journal* are still received.

The importance of maintaining the *Students' Journal*, and indeed all Students' activities, in as lively a form as possible has been stressed as providing means of maintaining one's sense of proportion, particularly when the present abnormal conditions are replaced by the equally difficult period of reconstruction after the war; from the support which is being given it would seem that this point of view is appreciated.

Though the exigencies of war time have prevented the full contact of pre-war years, visits have been made by the editor to various Sections, all of whom displayed a marked enthusiasm under difficult conditions.

The Sports Contest for the "Young" Trophy, which is in normal times competed for annually by the London Students' Section and the Students and Graduates of the Institutions of Civil and Mechanical Engineers, did not take place this year, and it is probable that any further Contest will be deferred until after the war. The London Section held the Trophy for the first three years of the Contest (1934–1936), and since then it has been held in turn by the Institution of Civil Engineers and the Institution of Mechanical Engineers.

(26) LOCAL HONORARY SECRETARIES ABROAD

During the session the Council appointed Mr. S. W. Redclift as Local Honorary Secretary of The Institution for India in place of Mr. K. G. Sillar who had resigned from this office, and Mr. M. A. Pike as Local Honorary Secretary for New Zealand in place of the late Mr. P. H. Mason.

(27) ACTIVITIES OF OVERSEAS MEMBERS

The Overseas Activities Committee of the Council are gratified that the activities of The Institution overseas have been maintained. Details have been received of meetings at which papers have been read and discussed, and of visits and other functions arranged by the Argentine and China Local Centres and by the Overseas Committees in Queensland, Bombay, Calcutta, Madras and Ceylon.

Arrangements were made to hold the Annual Conversazione and Reunion of members from overseas and their ladies in the Institution building on Thursday, 27th June, 1940, and the intention was that invitations should also be extended on this occasion to members serving in His Majesty's Forces. In view, however, of the uncertainty of the situation which developed at that time, it was considered advisable to cancel the function.

The Council are always anxious that The Institution should do everything possible to assist members from overseas, but more particularly in the present circumstances members coming from overseas, whether in civilian capacities or in connection with the Forces, will be especially welcome at The Institution.

It was reported to the Council in October last that letters had been received by the President from Dr. Gano Dunn, the Institution's Local Honorary Secretary in the United States of America, and from Mr. E. Hitchcock, President of the New Zealand Institution of Engineers, conveying their good wishes and especial sympathy at this present time and also their confidence in the ultimate success of British arms.

It is felt that members will warmly endorse the Council's appreciation on receiving these cordial messages of goodwill from brother engineers overseas.

(28) CO-OPERATION BETWEEN ENGINEERING INSTITUTIONS

The possibility of advancing co-operation between the engineering Institutions is always before the Council, and an instance of concerted action in connection with the war effort is referred to in paragraph (11).

Co-operation is also general in the areas of the Local Centres, where the Local Committees have done much to encourage activity in this respect.

In consequence of the present situation, the work of the Joint Committee on Engineering Co-operation Overseas has been suspended for the time being. It will be recollected that this Joint Committee on which the eight constituent institutions of the Engineering Joint Council are represented was set up to consider the possibility of fostering co-operation between overseas members of these institutions and, where there is a local engineering institution in existence, with the members of that institution, and to promote such co-operation in those countries as may be found to be practicable.

(29) EVACUATION OF CHILDREN TO CANADA AND AUSTRALIA

A generous and kind offer was received from the Engineering Institute of Canada to arrange for the reception, in the homes of members of that Institute, of the children of professional engineers in this country.

This offer was very gratefully accepted by The Institution and the Institutions of Civil and Mechanical Engineers and considerable headway had been made in making arrangements for the children of a number of members to be evacuated to Canada when the Government suspended the scheme which they had set up under the Children's Overseas Reception Board. As all arrangements for evacuation under the Engineering Institute of Canada's offer had to be incorporated in the Government scheme it was unfortunately not possible to proceed further with the matter.

A similar offer to that of the Canadian Institute was received from the Institution of Engineers of Australia and The Institution's grateful thanks were conveyed to them. No preliminary arrangements had, however, been made for the evacuation of the children of any members to Australia when the Government scheme referred to above was suspended.

(30) REVIEWS OF PROGRESS

Continuing the series of reviews of progress in electrical engineering which have appeared in the *Journal* each year since 1926, reviews on the following subjects will be published during 1941:—

Agricultural Applications of Electricity
Domestic Applications of Electricity
Electrical Insulating Materials
Electrical Measuring Instruments and Integrating Electricity Meters
Transmission and Distribution

Arrangements have been made for reviews on the following subjects in 1942:—

Standards of Electrical Measurement
Circuit Controlling Devices
and possibly a review dealing with electrical engineering developments in America.

(31) FARADAY LECTURE

In view of the prevailing conditions the Faraday Lecture by Mr. C. E. Fairburn, M.A., on the subject of "Electric Traction," which was postponed from last session, has been given this session at only one of the Local Centres, the North-Eastern Centre. The attendance at this Lecture was 268. Arrangements have been made for the Lecture to be delivered at a meeting of the Western Centre in April.

(32) SUMMER MEETING

In consequence of the war no Summer Meeting was held during 1940.

(33) COOPERS HILL WAR MEMORIAL PRIZE

The award of the Coopers Hill War Memorial Prize, which consists of a bronze medal, a parchment certificate and a money prize of £20, fell this year to The Institution, and the Council selected for the award Mr. J. S. Forrest, M.A., B.Sc., for his paper on "The Characteristics and Performance in Service of High-Voltage Porcelain Insulators." Ten papers were submitted for consideration.

Only Corporate Members of The Institution under 35 years of age are eligible to compete. Two awards are made each year, one annually by The Institution of Civil Engineers, and the other triennially in turn by The Institution of Electrical Engineers, the School of Military Engineering, Chatham, and the School of Forestry, Oxford.

(34) CHINESE ELECTRICAL ENGINEERING APPRENTICES AND STUDENTS

Mention has been made in previous Annual Reports of the Council's decision that facilities to attend Institution meetings and to use the Reference Library should, as a gesture of goodwill, be offered to Chinese electrical engineering apprentices and students who, under arrangements made by the Federation of British Industries, had been given opportunities for gaining engineering experience in Great Britain. Some 10 young men, whose names have been supplied by the Federation, come within the scope of the scheme at the present time. Those who are engaged in the provinces have, with the ready co-operation of the Local Centres and Sub-Centres concerned, been granted privileges as regards attendance at local meetings and the use of such library facilities as may be available.

(35) ANNUAL CONVERSAZIONE

The Annual Conversazione which normally takes place at the end of June each year was not held in 1940.

(36) ANNUAL DINNER

The Annual Dinner, which in the ordinary course of events would have been held in February, was again cancelled.

(37) LIBRARY

During the year 155 books and pamphlets have been presented to the Reference Library by members and others, and 41 volumes were purchased. The total number of readers for the year was 4 013, of whom 724 were non-members, as against 5 587 and 784 respectively in 1939–40.

Fifty new volumes have been added to the Lending Library and 1 901 books were issued to 981 borrowers, the corresponding numbers for the previous year being 2 224 and 1 042 respectively.

(38) THE JOURNAL OF THE INSTITUTION

The total number of pages comprised in the two volumes of the *Journal* for 1940 was 1 352 (excluding Plates), as compared with 1 580 in the two 1939 volumes.

The Council had under consideration before the war a scheme for sectionalizing the *Journal* in order to make it more useful and convenient to members. The increase in the cost of paper and postage last year, together with the severe rationing imposed by the Paper Controller on the Institution's supply of paper, rendered the question of the sub-division of the *Journal* a matter of urgency.

After very careful consideration the Council decided to divide the *Journal* into three Parts, namely Part I (General), Part II (Power Engineering) and Part III (Communication Engineering). The basis of the sub-division is that every member will receive each month a copy of Part I containing, in addition to material of general interest, abstracts of the papers which are accepted for publication in the other two Parts. These abstracts are intended to bring out the main principles for the benefit of those members who have no specialized knowledge of the subjects of the papers. The papers themselves will appear in full, together with the discussion (if any), in either Part II or Part III, according as they are classified under the "Power Engineering" or "Communication Engineering" headings. Occasionally papers of more general scope will appear in both Part II and Part III, or sometimes in Part I only.

Part I is being distributed free to members, but there is a small charge of 7s. 6d. per annum for Part II (issued in alternate months), and for Part III (issued quarterly), those Parts being supplied only to such members as make application for them. In the case of Students, and of Graduates up to the age of 28, the amount payable per annum for each of these Parts is reduced to 2s. 6d. Members not subscribing for Part II or Part III will be able to purchase particular issues of those Parts at the price of 2s. 6d. per copy.

Advance copies of papers read at meetings will still be available as hitherto on application to the Secretary, and requests for copies of such papers after their reading will be met in so far as surplus copies are available.

The sub-division of the *Journal* is regarded by the Council as primarily a war measure, and it will be subject to reconsideration and modification as may be found necessary from time to time. The scheme came into operation in January, 1941, and experience of it so far seems to show that it meets with the approval of nearly all the members, the majority of whom had found it impossible in recent years to read the large amount of specialized matter which was distributed to every member.

Over 5 500 members have up to the present expressed a desire to receive Part II, and over 3 000 to receive Part III.

In order to bring about closer co-operation with the American Institute of Electrical Engineers the Council have suggested to that body that an exchange of abstracts of papers in the proof stage might be arranged with a view to bringing electrical engineers in the two countries into more intimate touch with each other's work. If the suggestion is approved and is found to be practicable, the abstracts of the American Institute's papers selected for publication in the *Journal* would be included in Part I and would increase still further the usefulness of that Part.

A similar suggestion for the interchange of abstracts of papers has been made to the Institute of Radio Engineers.

(39) REGULATIONS FOR THE ELECTRICAL EQUIPMENT OF BUILDINGS

The revision of the Regulations is usually commenced shortly after the issue of an edition, but in the present circumstances the Council have decided that the revision of the Eleventh Edition be postponed for the time being. Matters arising in connection with the Eleventh Edition and requests for interpretation are being dealt with in the usual way.

Suggestions have been received that the Regulations should be amended to provide for alternative methods or materials necessitated by war conditions. Compliance with the Regulations is, however, a matter of contract between parties and any desired deviations should be set out in the contract, as it is neither practicable nor desirable to amend Regulations which are framed to indicate a standard of safety in order to take account of conditions which may change from time to time.

(40) REGULATIONS FOR THE ELECTRICAL EQUIPMENT OF SHIPS

There is a steady demand for copies of the Third Edition, which was issued in September, 1939, and of which further revision is not at present contemplated.

(41) MODEL GENERAL CONDITIONS FOR CONTRACTS

Additional clauses to the Model Form of General Conditions A (revised 1938) for use during the present war were issued in June, 1940.

A revision of Conditions C for the sale of goods other than cables at home without erection was published in December, 1940, and progress is being made with the preparation of additional clauses to these Conditions for use during the present war.

(42) "SCIENCE ABSTRACTS"

Science Abstracts, published monthly in two Sections, contains abstracts of articles from over 300 scientific and technical journals of the world.

Section "A," Physics Abstracts, deals with all branches of physics and physical chemistry. Section "B," Electrical Engineering Abstracts, deals not only with power engineering and telecommunication but also with certain branches of general engineering, such as testing, metallurgy, etc., of interest to electrical engineers. An inclusive index to each Section appears in the month of February.

It hardly needs stressing to-day that the engineer must keep abreast with the developments in his own subject, and classified abstracts present the matter in the most convenient form, not only for a survey of progress but for the filing of information for future reference as well. It should also be borne in mind that, in the search for a solution of any of the urgent problems now facing us, the engineer may obtain a valuable lead from his nearest ally, the physicist. The bound volumes of both Sections should form an important part of an engineer's reference library.

A subscriber may, as a rule, obtain the original of any article abstracted on short-period loan, by application to the editor, who would also be prepared to supply information of a bibliographical nature on any subject within the purview of *Science Abstracts*.

The publication may be obtained, if ordered, in advance, by Students of The Institution, as well as by Graduates up to the age of 28, at the special rate of 7s. 6d. per annum for both Sections, or 5s. for either the Physics or the Electrical Engineering Section, and by all other members of The Institution at 20s. for both Sections, or 12s. 6d. for either Section alone, the rate charged to the general public being £1 15s. per Section, or £3 for both Sections.

The number of copies issued to members is 2 250 per month, and to members of the societies with whom The Institution collaborates and the members of the public 5 478 per month. During the year under review 2 744 abstracts have been published in the Physics Section and 1 800 in the Electrical Engineering Section, as compared with 4 191 and 2 777 respectively for the previous year.

(43) OPERATING THEATRES ELECTRICAL APPARATUS COMMITTEE

As mentioned in the last Report, meetings of the Committee have had to be suspended for the time being on account of the war.

(44) ENGINEERING PUBLIC RELATIONS COMMITTEE

Since the outbreak of war the normal activities of the Engineering Public Relations Committee, upon which The Institution is represented, have been suspended, although arrangements have been made for it to meet if necessary to discuss any suggestions for war-time co-operation.

The ordinary function of this Committee is to act as an advisory body on "the dissemination of knowledge for the general advancement of engineering science by presenting to the public in suitable form information concerning the science and practice of engineering in its services to the public."

(45) BENEVOLENT FUND

The donations and subscriptions to the Fund in 1940 amounted to £3 640, in which amount are included the proceeds of collections made in lieu of Golf Competitions by the Mersey and North Wales (Liverpool) Centre (£73) and the North-Western Centre (£90).

Owing to the war the Electrical Engineers' Ball was not held in London in 1940, but gifts were received from the organizers of similar functions in the Provinces [£93 from the Mersey and North Wales (Liverpool) Centre Electrical Engineers' Ball, and £5 from the North-Eastern Students' Annual Dance]. Collections at meetings were made on behalf of the Fund by the North Midland Centre (£16) and the Western Centre and West Wales Sub-Centre (£18). A special donation of £191 was received from Mr. H. Marryat.

In the course of the year grants were made to 83 persons, amounting to a total of £3 952. In assisting these cases the Fund also provided for the needs of 63 dependants.

It will be noted from the Accounts for 1940 that the financial position of the Fund has improved, and that there is at present a small surplus of income over expenditure.

Owing to shortage of paper and for reasons of economy, a list of contributors was not published in 1940. This will be resumed as soon as conditions permit.

The Council earnestly hope that all members of The Institution will continue to give the Fund their active support. The Fund is able, under the provisions of the Finance Act, 1922, to recover income tax on annual subscriptions, provided that the subscribing member signs a deed of covenant to give a fixed amount per annum for a minimum period of 7 years, subject to cancellation after death. A number of contributors (approximately 200) have agreed to subscribe under this arrangement, and if any other members wish to do so the Honorary Secretary of the Fund will be pleased to supply the necessary forms and particulars.

The Committee wish to express great appreciation to the Local Honorary Treasurers for their efforts in stimulating an active interest in the Fund among the members in the Local Centres, and for their valuable assistance in the investigation of applications.

(46) THE INSTITUTION AND BODIES ON WHICH IT IS REPRESENTED

Appendix D (page 225) shows in diagrammatic form the organization of The Institution and the bodies on which it is represented.

[Appendices A, B, C and D to the Report will be found on pages 224 and 225.]

APPENDIX A

Membership of The Institution

The changes in the membership since the 1st April, 1940, are shown in the following table:—

	Hon. Mem.	Mem.	Assoc. Mem.	Com.	Assoc.	Grad.	Stud.	Total
Totals at 1 April, 1940	10	2 136	7 692	100	1 365	4 909	3 660	19 872
Additions during the year:—								
Elected ..	1	—	148	—	78	211	843	1 281
Reinstated ..	—	1	4	—	3	3	10	21
Transferred to ..	—	59	358	—	6	364	—	787
Totals ..	1	60	510	—	87	578	853	2 089
Deductions during the year:—								
Deceased ..	3	62	64	4	13	21	19	186
Resigned ..	—	9	28	1	9	35	31	113
Lapsed ..	—	12	51	3	31	109	394	600
Transferred from ..	—	—	59	—	40	312	376	787
Totals ..	3	83	202	8	93	477	820	1 686
Net Increase								403
Totals at 1 April, 1941	8	2 113	8 000	92	1 359	5 010	3 693	20 275

APPENDIX B

Growth of Membership for the last 15 years

Year (31st March)	Corporate Members	Non-Corporate Members	Total Membership	Increase
1927	6 829	5 818	12 647	505
1928	7 080	5 963	13 043	396
1929	7 328	6 233	13 561	518
1930	7 501	6 699	14 200	639
1931	7 646	7 024	14 670	470
1932	7 804	7 080	14 884	214
1933	7 937	7 212	15 149	265
1934	8 142	7 477	15 619	470
1935	8 317	7 833	16 150	531
1936	8 569	8 219	16 788	638
1937	8 842	8 557	17 399	611
1938	9 110	9 142	18 252	853
1939	9 462	9 582	19 044	792
1940	9 838	10 034	19 872	828
1941	10 121	10 154	20 275	403

APPENDIX C

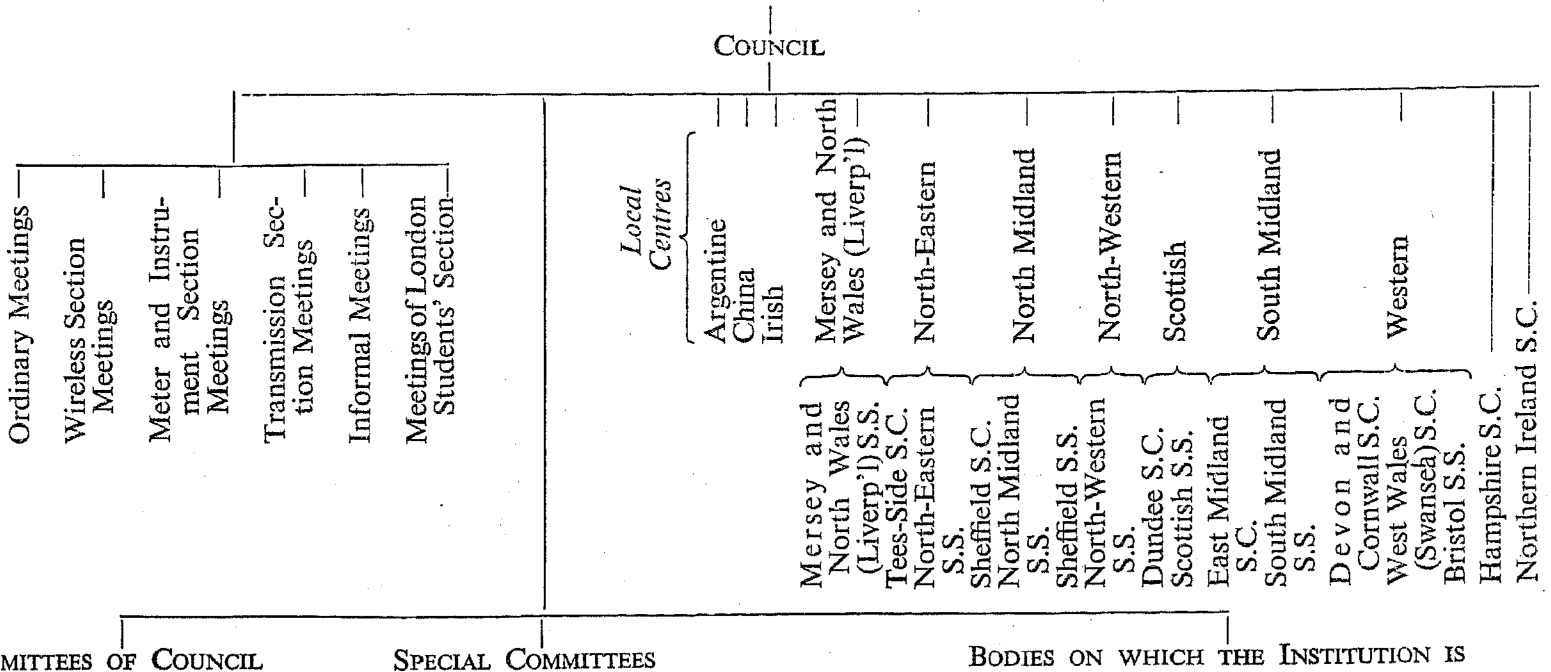
Meetings

The following is a list of the meetings held during the past 12 months:—

Ordinary Meetings ..	8
Annual General Meeting	1
Annual General Meeting (Benevolent Fund)	1
Wireless Section ..	3
Meter and Instrument Section	2
Transmission Section	2
Informal Meetings ..	2
Council Meetings ..	11
Local Centres:	
Irish	5
Mersey and North Wales (Liverpool)	5
North-Eastern ..	11
North Midland ..	6
North-Western ..	8
Scottish	9
South Midland ..	2
Western	7
Local Sub-Centres:	
Devon and Cornwall	-
Dundee	5
East Midland ..	6
Hampshire	3
Northern Ireland ..	8
Sheffield	1
Tees-Side	6
West Wales (Swansea)	7
Students' Sections:	
Bristol	–
Liverpool	3
London	3
North-Eastern ..	9
Students' Sections—*contd.*	
North Midland ..	10
North-Western ..	7
Scottish	9
Sheffield	5
South Midland ..	4
Committees:	
Benevolent Fund ..	9
Education and Examinations ..	8
Emergency	2
Finance (and Sub-Committee) ..	13
General Purposes ..	4
Informal Meetings	1
Membership ..	8
Meter and Instrument Section (and Sub-Committees)	10
National Certificates (England) ..	1
National Certificates (Scotland) ..	1
National Service ..	2
Overseas Activities	1
Papers	9
Scholarships ..	1
Science Abstracts ..	2
Transmission Section (and Sub-Committees) ..	6
Wireless Section (and Sub-Committees)	9
Other Committees ..	11
Total ..	267

APPENDIX D

THE INSTITUTION OF ELECTRICAL ENGINEERS



NOTE.—S.C. denotes a Sub-Centre, and S.S. a Students' Section.

COMMITTEES OF COUNCIL

Education and Examinations
Finance
General Purposes
Library and Museum
Membership
Papers

SPECIAL COMMITTEES

Benevolent Fund
Earthing to Water Mains (Joint)
Electrical Engineers' Ball
Electricity (Supply) Regulations
Emergency
Faraday Medal and Honorary Membership Advisory
Home Security Advisory
Informal Meetings
International Relations
Local Centres
Meter and Instrument Section
Model General Conditions
National Service
Operating Theatres Electrical Apparatus
Overseas Activities
Patent Law
Post-War Planning
Scholarships
Science Abstracts
Ship Electrical Equipment Regulations
Transmission Section
Wireless Section
Wiring Regulations

Technical Committees

Applications and Plant
Education and Training
Electricity in Mines
Electrochemistry and Electrometallurgy
Power Stations and their Equipment
Radiological and Electromedical Apparatus
Telegraphs and Telephones
Traction, including Railways

Overseas Committees

Ceylon
India (Bombay, Calcutta, Lahore, and Madras)
New South Wales
Queensland
South Australia
Victoria and Tasmania
Western Australia
New Zealand
Transvaal

BODIES ON WHICH THE INSTITUTION IS REPRESENTED

Bristol University
British Cast Iron Research Association
British Electrical and Allied Industries Research Association
British Electrical Development Association, Committee on Rural and Agricultural Electrification
British National Illumination Committee of the International Commission on Illumination
British Standards Institution
Building Industries National Council, Advisory Committee on Building Acts and Bye-laws
City and Guilds of London Institute
Council for the Preservation of Rural England
Electrical Association for Women
Engineering Joint Council
Engineering Joint Examination Board
Engineering Public Relations Committee
H.T. Conference, Paris, British National Committee
Imperial College of Science and Technology, Governing Body
Imperial Minerals Resources Conference, Copper Committee
Institute of Industrial Administration, Examinations Advisory Council
Institute of Metals, Corrosion Research Committee
Institution of Civil Engineers, Engine and Boiler Testing Committee
Institution of Civil Engineers, Engineering Precautions (Air Raid) Committee Panel
International Association for Testing Materials
International Electrotechnical Commission, British National Committee
Joint Committee on Engineering Co-operation Overseas
Joint Committee on Materials and their Testing
Joint Committee of The Institution of Civil Engineers and the E.R.A. for Research on Earthing to Water Mains
Manchester Regional Advisory Council for Technical and other forms of Further Education
Metalliferous Mining (Cornwall) School, Governing Body
Ministry of Labour, Central Register Advisory Council, Central Register General Purposes Committee, Central Register General Engineering Committee, Central Register Electrical Engineering Sub-Committee and Panel
National Certificates and Diplomas in Electrical Engineering, Joint Committees for
National Committee on Physics (Royal Society)
National Committee on Scientific Radio (Royal Society)
National Physical Laboratory, General Board
National Register of Electrical Installation Contractors
National Smoke Abatement Society
Professional Classes Aid Council
Science Museum, South Kensington, Advisory Council
Town Planning Institute, Committee on Overhead Transmission Lines

[*Continued at foot of column* 2.]

[*Continued from foot of column* 3.]

Union of Lancashire and Cheshire Institutes, Panel for Engineering
University College, Nottingham, Electrical Engineering Advisory Committee
War Office Mechanization Board
Women's Engineering Society
World Power Conference, British National Committee

THE INSTITUTION OF ELECTRICAL ENGINEERS

REVENUE ACCOUNT FOR THE YEAR ENDED 31st DECEMBER, 1940

DR. EXPENDITURE

Year ended 31 Dec., 1939. £		£	£
	To MANAGEMENT:—		
	Salaries and Wages	16,903	
	Cost of Living Bonus	121	
	Staff Provident Scheme	1,874	
	National Insurance	160	
	Printing	474	
	Stationery and Office Requisites	881	
	Addressing Machine Requisites	72	
	Postage of Correspondence and Notices	1,237	
	Telephone	142	
	Travelling Expenses	205	
23,346			22,069
	,, INSTITUTION BUILDING:—		
	Ground Rent	2,201	
	Rates	3,849	
	Heating	1,579	
	Lighting and Power	474	
	Insurance	236	
	Transferred to Repairs Suspense Account	1,000	
	Household Requisites and Cleaning	701	
	Fire Extinguishing Equipment	141	
		10,181	
	Less Rents from Tenants	5,525	
3,576			4,656
	,, AIR RAID PRECAUTIONS:—		
	Headquarters	388	
	Weybridge	1,057	
		1,445	
	Less Amount received towards Cost of Shelter	751	
2,380			694
166	,, FURNITURE AND FITTINGS (Repairs and Renewals)		336
265	,, CENTRAL REGISTER OF NATIONAL SERVICE		69
1,129	,, HISTORY OF THE INSTITUTION		nil
	,, JOURNAL:—		
	Printing	8,644	
	Postage	3,187	
	Wrappers and Envelopes	566	
		12,397	
	Less Sales and Advertisements	3,271	
9,301			9,126
176	,, PROCEEDINGS OF THE WIRELESS SECTION (Printing, Postage, etc.: *less* Sales)		82
651	,, STUDENTS' QUARTERLY JOURNAL (Editing, Printing, Postage, etc.: *less* Sales)		556
154	,, LENDING LIBRARY (Books, Printing, Postage, etc.)		111
	,, SCIENCE ABSTRACTS:—		
	Abstracting, Editing, Printing, Postage, etc.	5,526	
	Less Sales and Advertisements	4,839	
594			687
	Carried Forward		£38,386

INCOME CR.

Year ended 31 Dec., 1939. £		£	£
48,052	BY SUBSCRIPTIONS		48,590
1,467	,, ENTRANCE FEES		1,441
767	,, MEMBERS' SUBSCRIPTIONS TO "SCIENCE ABSTRACTS"		744
6,075	,, DIVIDENDS AND INTEREST		5,843
188	,, SALES OF "MODEL GENERAL CONDITIONS"		96
164	,, SALES OF "WIRING REGULATIONS"		156
48	,, SALES OF "SHIP WIRING REGULATIONS"		27
	,, SALES OF "HISTORY OF THE INSTITUTION"		49
	,, EXAMINATIONS:—		
	Graduateship Examination (Candidates' Fees and Sale of Papers, *less* Examiners' Fees, Printing, etc.)	506	
	National Certificates and Diplomas (Candidates' and School Authorities' Fees, *less* Assessors' Fees, Stationery, Postage, Travelling Expenses, etc.)	858	
1,574			1,364
	Carried Forward		£58,310

REVENUE ACCOUNT—*continued*

DR.	EXPENDITURE—*continued*	£	£		INCOME—*continued*	CR. £
	Brought Forward		38,386		Brought Forward	58,310
	To INSTITUTION MEETINGS:—					
	Advance Proofs	384				
	Reporting	96				
	Grant to London Students' Section	39				
	Honorarium to Kelvin Lecturer	25				
	Refreshments, Assistance, etc.	283				
	Travelling Expenses of Authors of Papers ..	38				
	Overseas Meetings	108				
1,385			973			
	,, LOCAL CENTRES:—					
	Money Grants	2,762				
	Travelling Expenses	473				
	Students' Lectures	70				
5,248			3,305			
326	,, PREMIUMS FOR PAPERS		268			
	,, SCHOLARSHIPS:—					
	Ferranti Scholarship	271				
	Duddell Scholarship	450				
	Silvanus Thompson Scholarship	77				
	Contribution to Salomons Scholarship	42				
	Contribution to David Hughes Scholarship ..	21				
1,069			861			
	,, SPECIAL GRANTS:—					
	British Standards Institution	750				
	Electrical Research Association	750				
	National Illumination Committee	32				
	International Conference on High Tension Systems	32				
	World Power Conference	12				
	Joint Committee on Materials and their Testing	10				
	" Earthing to Water Mains " Joint Committee ..	50				
1,701			1,636			
211	,, SHIP WIRING REGULATIONS (Cost of printing new edition)		nil			
108	,, ANNUAL DINNER		nil			
717	,, CONVERSAZIONES		nil			
121	,, AUDIT FEE		121			
251	,, LEGAL EXPENSES		317			
121	,, MISCELLANEOUS EXPENSES		166			
877	,, LOSS ON EXCHANGE ON OVERSEAS DEPOSITS REMITTED TO LONDON		1,024			
53,873			47,057			
278	,, AMOUNT TRANSFERRED TO SINKING FUND (Premiums for Redemption of Cost of Building and Lease)	278				
4,184	,, **Balance carried to Balance Sheet**	10,975				
4,462			11,253			
58,335			£58,310	*58,335*		£58,310

BALANCE SHEET, 31st DECEMBER, 1940

LIABILITIES

	£	£
UNINVESTED BALANCES OF TRUST FUNDS		592
SUNDRY CREDITORS		5,411
SUBSCRIPTIONS RECEIVED IN ADVANCE		1,117
REPAIRS SUSPENSE ACCOUNT:—		
Balance at 1st January, 1940	4,018	
Amount set aside in 1940	1,000	
	5,018	
Less Expenditure on Repairs in 1940	343	
		4,675
Carried Forward		£11,795

ASSETS

	£	£
INSTITUTION BUILDING AND LEASE:—		
Cost	73,028	
Less Reserve for Depreciation, being Surrender Values of Sinking Fund Policies	12,704	
		60,324
SINKING FUND (Surrender Values of Policies for Redemption of Cost of Building and Lease)		12,704
LIBRARY (exclusive of the Ronalds Library and Faraday Papers, which are held in trust):—		
As per last Balance Sheet	1,981	
Additions in 1940	165	
	2,146	
Less Depreciation (10 %)	215	
		1,931
THOMPSON MEMORIAL LIBRARY (Contribution towards purchase)		1,000
FURNITURE, FITTINGS, AND APPARATUS:—		
As per last Balance Sheet	2,878	
Less Depreciation (5 %)	144	
		2,734
SUNDRY DEBTORS		2,756
INSURANCE PREMIUMS AND SUNDRY PAYMENTS IN ADVANCE		1,672
STOCK OF PAPER, ETC., FOR PUBLICATIONS		1,245
SPECIAL SUSPENSE ACCOUNT:—		
Expenditure during 1940		1,002
INVESTMENTS (at or under cost):—		
£2,600 Natal Zululand Railways 3 % Debenture Stock	2,271	
£1,500 London, Midland and Scottish Railway 4 % Preference Stock	1,514	
£2,000 Assam Bengal Railways 3 % Stock (1931 or after)	1,548	
£750 Western Australia 4 % Stock (1942–62)	730	
£750 Union of South Africa 4 % Stock (1943–63)	743	
£35 East Indian Railway " B " Annuity (1953)	791	
£1,500 South Australia 4 % Stock (1940–60)	1,495	
£6,450 3½ % War Stock	6,306	
£19,375 4 % Funding Loan (1960–90)	15,500	
£8,700 3½ % Conversion Stock (1961 or after)	6,651	
£11,970 11s. 4 % Consolidated Stock	10,291	
£1,000 London, Midland and Scottish Railway 5 % Preference Stock (1955)	1,020	
£4,100 North Metropolitan Power Station 5 % Guaranteed Debenture Stock (1957)	4,089	
£2,000 London, Midland and Scottish Railway 5 % Redeemable Debenture Stock (1952)	1,982	
Carried Forward	£54,931	£85,368

BALANCE SHEET—*continued*

LIABILITIES—*continued*

			£	£
Brought Forward				11,795
Surplus of Assets over Liabilities:—				
Balance at 1st January, 1940			223,352	
Excess of Income over Expenditure for 1940 brought forward from Revenue Account		£10,975		
Less Depreciation:—				
Library (*per contra*)	£215			
Furniture, Fittings, and Apparatus (*per contra*)	144			
		359		
			10,616	
				233,968
				£245,763

ERNEST LEETE,
Honorary Treasurer.

W. K. BRASHER,
Secretary.

ASSETS—*continued*

	£	£
Brought Forward		85,368
INVESTMENTS (at or under cost)—*contd.*		
Brought forward	54,931	
£2,300 East Indian Railway 4½ % Irredeemable Debenture Stock	2,020	
£5,000 Commonwealth of Australia 5 % Stock (1945–75)	4,965	
£2,000 Tynemouth Corporation 5 % Stock (1947–57)	2,025	
£2,500 Stoke-on-Trent Corporation 5 % Stock (1948–68)	2,550	
£3,500 East Indian Railway 3½ % Debenture Stock (1937)	2,476	
£5,000 Brighton Corporation 4¾ % Stock (1945–75)	5,050	
£2,000 New South Wales 5¼ % Stock (1947–57)	2,014	
£2,600 Kenya Government 4½ % Stock (1950)	2,483	
£3,000 Southern Railway 4 % Debenture Stock	2,520	
£2,500 Corporation of London 4½ % Debenture Stock (1940–85)	2,463	
£3,000 Birmingham Corporation 4½ % Stock (1948–68)	2,906	
£3,000 London County 4½ % Stock (1945–85)	2,937	
£1,000 Bootle Corporation 4¾ % Stock (1949–59)	968	
£12,000 2¾ % Funding Loan (1952–57)	10,158	
£2,000 Southampton Corporation 5 % Stock (1947–67)	2,028	
£4,881 London Passenger Transport Board 4½ % "A" Stock (1985–2023)	4,440	
£2,000 Agricultural Mortgage Corporation 5 % Debenture Stock (1959–89)	2,081	
£2,400 Ayr County Council 5 % Stock (1947–57)	2,484	
£2,400 Union of South Africa 5 % Stock (1950–70)	2,436	
£1,000 Nyasaland Government 4½ % Guaranteed Stock (1952–72)	1,143	
£2,500 London Passenger Transport Board 5 % "B" Stock (1965–2023)	3,017	
£5,000 London County 2¾ % Consolidated Stock (1960–70)	4,811	
£5,600 3 % Funding Loan (1959–69)	5,420	
£3,000 Birmingham Corporation 3¼ % Stock (1957–62)	2,953	
£2,000 3 % Redemption Loan (1986–96)	1,843	
£5,600 Ipswich Corporation 3¼ % Stock (1964)	5,303	
£2,200 Manchester Corporation 3 % Stock (1958–63)	2,013	
£6,000 3 % War Stock (1955–59)	5,996	
£3,000 2½ % National War Bonds (1945–47)	3,000	
Loan to H.M. Government (free of interest)	2,000	
(*Market value* 31*st December*, 1940, £168,632)		151,434
CASH AT BANKS IN AUSTRALIA AND NEW ZEALAND (*Sterling equivalent* 31*st December*, 1940, £2,748)		3,442
CASH IN HANDS OF LOCAL CENTRES ON 30TH SEPT., 1940		1,325
CASH:—		
At Bank	3,861	
In hands of Secretary	333	
		4,194
		£245,763

We beg to report that we have audited the Balance Sheet of The Institution of Electrical Engineers, dated 31st December, 1940, and above set forth, together with the annexed Statements of Account. We have obtained all the information and explanations we have required. In our opinion the Statements are correct and the Balance Sheet is properly drawn up so as to exhibit a true and correct view of the state of The Institution's affairs according to the best of our information and the explanations given to us and as shown by the books of The Institution.

10*th April*, 1941.

ALLEN, ATTFIELD & Co., Auditors,
Chartered Accountants,
24, MARTIN LANE, CANNON STREET, E.C.4.

SALOMONS SCHOLARSHIP TRUST FUND

CAPITAL ACCOUNT

DR.	£	s.	d.	CR.	£	s.	d.
To Amount (as per last Account)	2,085	1	4	By Investments (at cost):—			
				£1,600 13s. 3d. Commonwealth of Australia 3% Stock (1955–58)	1,585	1	4
				£500 Cardiff Corporation 3% Stock (1952–55)	500	0	0
	£2,085	1	4		£2,085	1	4

INCOME ACCOUNT

DR.	£	s.	d.	CR.	£	s.	d.
To Amount paid to Scholars in 1940	100	0	0	By Dividends received in 1940	57	10	10
				,, Contribution from Institution	42	9	2
	£100	0	0		£100	0	0

DAVID HUGHES SCHOLARSHIP TRUST FUND

CAPITAL ACCOUNT

DR.	£	s.	d.	CR.	£	s.	d.
To Amount (as per last Account)	2,000	0	0	By Investment (at cost):—			
				£2,045 Metropolitan Water Board (Staines Reservoirs) 3% Guaranteed Debenture Stock (1922 or after)	1,998	15	0
				,, Balance carried to Balance Sheet*	1	5	0
	£2,000	0	0		£2,000	0	0

INCOME ACCOUNT

DR.	£	s.	d.	CR.	£	s.	d.
To Amount paid to Scholar in 1940	75	0	0	By Dividends received in 1940	53	13	8
				,, Interest received in 1940	0	0	6
				,, Contribution from Institution	21	5	10
	£75	0	0		£75	0	0

PAUL SCHOLARSHIP FUND

CAPITAL ACCOUNT

DR.	£	s.	d.	CR.	£	s.	d.
To Amount (as per last Account)	1,000	0	0	By Investments (at cost):—			
				£625 4% Funding Loan (1960–90) ..	500	0	0
				£518 3s. 8d. Central Electricity Board 5% Debenture Stock (1950–70)	500	0	0
	£1,000	0	0		£1,000	0	0

INCOME ACCOUNT

DR.	£	s.	d,	CR.	£	s.	d.
To Amount paid to Scholar in 1940	50	0	0	By Balance (as per last Account)	22	1	9
,, Balance carried to Balance Sheet*	19	2	3	,, Dividends received in 1940	47	0	6
	£69	2	3		£69	2	3

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* Included in the total of £592 shown on the Liabilities side of the Balance Sheet.

WILDE BENEVOLENT TRUST FUND

CAPITAL ACCOUNT

Dr.	£	s.	d.	Cr.	£	s.	d.
To Amount (as per last Account)	3,049	16	2	By Investments (at cost):—			
				£1,308 London and North Eastern Railway 4 % First Guaranteed Stock	1,744	3	11
				£100 London County 2¾ % Consolidated Stock (1960–70)	101	8	6
				£250 New South Wales 4 % Stock (1942–62)	251	6	0
				£500 3½ % War Stock	501	9	3
				£381 15s. 1d. 4 % Funding Loan (1960–90)	300	0	0
				£200 3½ % Conversion Stock (1961 or after)	151	8	6
	£3,049	16	2		£3,049	16	2

INCOME ACCOUNT

Dr.	£	s.	d.	Cr.	£	s.	d.
To Grant made in 1940	100	0	0	By Balance (as per last Account)	92	3	6
,, Balance carried to Balance Sheet*	88	6	8	,, Dividends received in 1940	95	14	8
				,, Interest received in 1940	0	8	6
	£188	6	8		£188	6	8

WAR THANKSGIVING EDUCATION AND RESEARCH FUND (No. 1)

CAPITAL ACCOUNT

Dr.	£	s.	d.	Cr.	£	s.	d.
To Amount (as per last Account)	1,700	0	0	By Investment (at cost):—			
				£2,000 3½ % War Stock	1,700	0	0
	£1,700	0	0		£1,700	0	0

INCOME ACCOUNT

Dr.	£	s.	d.	Cr.	£	s.	d.
To Balance carried to Balance Sheet*	131	5	0	By Balance (as per last Account)	61	5	0
				,, Dividends received in 1940	70	0	0
	£131	5	0		£131	5	0

PAGE PRIZE FUND

CAPITAL ACCOUNT

Dr.	£	s.	d.	Cr.	£	s.	d.
To Amount (as per last Account)	100	19	5	By Investments (at cost):—			
				£50 3½ % War Stock	50	19	5
				£51 16s. 4d. Central Electricity Board 5% Debenture Stock (1950–70)	50	0	0
	£100	19	5		£100	19	5

INCOME ACCOUNT

Dr.	£	s.	d.	Cr.	£	s.	d.
To Cost of Prize awarded in 1940	5	0	0	By Balance (as per last Account)	8	13	8
,, Balance carried to Balance Sheet*	7	12	8	,, Dividends received in 1940	3	19	0
	£12	12	8		£12	12	8

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* Included in the total of £592 shown on the Liabilities side of the Balance Sheet.

THORROWGOOD SCHOLARSHIP TRUST FUND

CAPITAL ACCOUNT

DR.	£	s.	d.	CR.	£	s.	d.
To Amount (as per last Account)	1,000	0	0	By Investment (at cost):— £1,005 Agricultural Mortgage Corporation 5 % Debenture Stock (1959–89) ..	1,000	0	0
	£1,000	0	0		£1,000	0	0

INCOME ACCOUNT

DR.	£	s.	d.	CR.	£	s.	d.
To Amount paid to Scholars in 1940	37	10	0	By Balance (as per last Account)	60	6	2
,, Balance carried to Balance Sheet*	66	15	7	,, Dividends received in 1940	43	19	5
	£104	5	7		£104	5	7

SWAN MEMORIAL SCHOLARSHIP FUND

CAPITAL ACCOUNT

DR.	£	s.	d.	CR.	£	s.	d.
To Amount (as per last account)	2,968	12	4	By Investments (at cost):—			
				£1,000 Sunderland Corporation 5 % Stock (1946–56)	1,116	13	0
				£640 Sunderland Corporation 5 % Stock (1950–60)	728	8	0
				£1,135 17s. 9d. 3½ % Conversion Stock (1961 or after)	1,123	11	4
	£2,968	12	4		£2,968	12	4

INCOME ACCOUNT

DR.	£	s.	d.	CR.	£	s.	d.
To Amount paid to Scholar in 1940	90	0	0	By Balance (as per last Account)	9	6	3
,, Balance carried to Balance Sheet*	22	15	11	,, Dividends received in 1940	103	9	8
	£112	15	11		£112	15	11

WILLIAM BEEDIE ESSON SCHOLARSHIP TRUST FUND

CAPITAL ACCOUNT

DR.	£	s.	d.	CR.	£	s.	d.
To Amount (as per last Account)	3,006	2	6	By Investments (at cost):—			
				£1,500 3½ % War Stock	1,603	2	6
				£200 New Zealand 5 % Stock (1949) ..	233	0	0
				£250 St. Helens Corporation 5 % Stock (1950–70)	293	15	0
				£250 Sunderland Corporation 5 % Stock (1950–60)	293	15	0
				£250 Birmingham Corporation 5 % Stock (1946–56)	291	5	0
				£250 Grimsby Corporation 5 % Stock (1950–60)	291	5	0
	£3,006	2	6		£3,006	2	6

INCOME ACCOUNT

DR.	£	s.	d.	CR.	£	s.	d.
To Amount paid to Scholar in 1940	72	19	6	By Balance (as per last Account)	223	19	10
,, Balance carried to Balance Sheet*	255	5	4	,, Dividends received in 1940	104	5	0
	£328	4	10		£328	4	10

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* Included in the total of £592 shown on the Liabilities side of the Balance Sheet.

PROCEEDINGS OF THE INSTITUTION

966TH ORDINARY MEETING, 8TH MAY, 1941

Mr. J. R. Beard, M.Sc., President, took the chair at 2.30 p.m.

The minutes of the meeting held on the 3rd April, 1941, were taken as read and were confirmed.

A list of candidates for election and transfer, approved by the Council for ballot, was taken as read and was ordered to be suspended in the Hall.

The President announced that during the month of April 288 donations and subscriptions to the Benevolent Fund had been received, amounting to £111. A vote of thanks was accorded to the donors.

The President: My first duty this afternoon, and it is a most agreeable and unusual duty, is to present, on behalf of The Engineering Institute of Canada, their Sir John Kennedy Medal to Lieut.-General Andrew George Latta McNaughton, C.B., C.M.G., D.S.O., M.Sc., LL.D., D.C.L., General Officer Commanding the Canadian Forces in Great Britain. We esteem it a great privilege that this presentation should have been entrusted to us, more especially as General McNaughton is one of our members.

For some time past we, in common with the Institutions of Civil and Mechanical Engineers, have wished to foster closer collaboration with the representative engineering institutions in the Dominions, and this was actively in hand until necessarily interrupted by the outbreak of war. We intend to take it up again when the war is over, and meanwhile this function to-day helps to keep the spirit of co-operation alive.

Three years ago The Engineering Institute of Canada celebrated its Jubilee, and representatives of our Institutions under the leadership of Sir Alexander Gibb went to Canada to offer our congratulations. We were ably represented by my immediate predecessor, Mr. Johnstone Wright, who brought back most happy memories of Canada and an increased enthusiasm for the encouragement of co-operation between our Institutions.

The Sir John Kennedy Medal is awarded, when occasion merits, to Corporate Members of The Engineering Institute of Canada "in recognition of outstanding merit in the profession or of noteworthy contribution to the science of engineering" and I understand that this is only the fifth or sixth award which has been made. General McNaughton fully meets those requirements, in addition to having given most distinguished service to Canada in wider fields.

Born in Saskatchewan in 1887, General McNaughton graduated in electrical engineering at McGill University, where he was subsequently on the teaching staff and in private practice. From his undergraduate days he had taken the keenest interest in military science and by 1913 was a Major commanding a field battery in the Militia. During the 1914–1918 war he gave distinguished service in France and was wounded at Ypres. He rose to be Lieut.-Colonel in charge of a field artillery brigade in the 2nd Canadian Division, fought through the battles of the Somme, during which he was again wounded, and became counter battery staff officer of the Canadian Corps; he was again wounded at Soissons in 1918 while attached to the French Army. Just prior to the end of the war he was General Officer Commanding Canadian Corps Heavy Artillery at the early age of 31. Apart from the several honours and distinctions which I have enumerated, he was mentioned three times in dispatches.

On his return to Canada, General McNaughton became successively Director of Military Training, Deputy Chief of the General Staff and, in 1929, Chief of the General Staff, with the rank of Major-General, which I understand is the highest military appointment in Canada. During this period he continuously stressed the rapidly increasing importance of the engineer in modern warfare, a view which has been fully justified in recent months. He was also active in afforestation.

In 1935 he became President of the Canadian National Research Council, a position which he still occupies, and his energy has done much to promote the constructive application of science to industry.

In electrical engineering his development of the cathode-ray direction-finder, in co-operation with Col. W. A. Steel, is well known. At the Research Council he promoted work on high-voltage investigations and not only equipped the laboratories for this purpose but took an active part in planning the experimental programme. In 1939 he was appointed by the Canadian Government as technical adviser to accompany a delegation of Canadian manufacturers to Great Britain in order to investigate the possibility of producing munitions in Canadian plants.

Throughout his military career General McNaughton has always directed his attention especially to the scientific and engineering side. Signals, radio, aircraft, artillery and mechanization have been his chief interests. In many other directions he has played an active part, such as in the St. Lawrence waterways and air transport.

Soldier, scientist and skilful administrator, a Canadian with a true understanding of the place Canada holds in world affairs and with a broad vision of the future which its potential resources may enable it to attain, General McNaughton has devoted his life in large measure to the development of Canada, the promotion and application of engineering science and the advancement of his chosen profession.

We had hoped to have with us this afternoon the Hon. Mr. Vincent Massey, High Commissioner for Canada, but unfortunately, though he fully intended to come, he has at the last minute been called to a very urgent appointment and has had to forgo giving us the pleasure of his presence. We have with us to-day, however, the former Prime Minister of Canada, the Rt. Hon. Mr. R. B. Bennett, who is very well known to us over here and who, as you know, has taken up his residence among us. We are also pleased to welcome several distinguished technical officers of the Canadian Forces.

Our Council feel that they would like to make a record of this occasion by presenting to The Engineering Institute of Canada an Address stating the circumstances of this presentation and their pleasure at being invited to make it. A copy of the Address is also being handed to General McNaughton. [The President then, amid applause, handed to General McNaughton the Sir John Kennedy Medal of The Engineering Institute of Canada and a copy of the Address.]

Lieut.-General A. G. L. McNaughton: I know you will forgive me if my remarks on this occasion are very brief, because you will understand that the high honour which I have received to-day from The Engineering Institute of Canada, through the agency of The Institution of Electrical Engineers, goes right to my heart. I feel very much that the recognition which has been given to me is to a very large extent a recognition of that great institution, the National Research Council, with which I have the honour to be associated and to which I was sent by the Rt. Hon. Mr. Bennett, whose presence here to-day I deeply appreciate.

I have sought all my life to have an opportunity of taking part in actual development work and construction work in engineering, but it always seems that as soon as one starts an active project of investigation or research something happens in the world and one is drawn away to outside activities. Twice in my life, once at McGill and then at the Research Council, I have gone deeply into the field of high-voltage research, but no sooner had I got the equipment assembled on those two occasions than war in Europe broke out. I can assure you, however, that Mr. Ballard and my other associates in Canada who are continuing to use and develop the Research Council's laboratory are keeping me informed of what is going on, and as soon as the war is brought to a satisfactory conclusion—I have no doubt about its ultimate result—I want to continue my work there with the beautiful apparatus that we have got together, operating at millions of volts with much power behind them and at many frequencies. I hope some day to have the privilege of presenting a paper to this Institution.

The President: I now come to another very pleasant duty, namely the presentation of the Faraday Medal which has been awarded by the Council to Dr. A. P. M. Fleming, C.B.E., D.Eng., M.Sc. As he is a recent President and a most active Member of Council, particularly in connection with the Institution's work for the Ministry of Labour and National Service, there is no need for me to refer to his work for our Institution, but I think it would be appropriate if I gave some indication of his distinguished work in wider fields, particularly those of engineering education and training and the organization of research.

Prior to 1914 Dr. Fleming was superintendent of the British Westinghouse Transformer Department, and their insulation specialist. During this period he initiated an apprenticeship training scheme, which was a model for many such schemes, and he established a works school for training trade apprentices. This was followed by schemes for training public and secondary school boys, and graduates from universities all over the Empire. More than 7 000 apprentices of all grades, inclusive of 2 000 graduates of universities, have benefited from these courses. As chairman for Post-Advanced Engineering Courses in the North-Western Region, Dr. Fleming carries his interest in engineering education well beyond the apprenticeship age. He served on Lord Lytton's Commission on Indian Students, the Board of Education's Committee on Education for the Electrical Industry, and the Board of Education and Board of Trade Commission on the Training of Students for Overseas. He is chairman of the B.E.A.M.A. Committee on Education, and serves on the Committee of Education of the Federation of British Industries. He also occupied the distinguished position of chairman of the Education Section of the British Association in 1939. Several universities have invited Dr. Fleming to serve on their Courts, thereby acknowledging his eminence in educational and industrial spheres.

In 1916 Dr. Fleming created the British Westinghouse Research Department, which was one of the earliest industrial research organizations and has grown to be one of the largest industrial research laboratories in the country. On behalf of the Department of Scientific and Industrial Research he reported on industrial research in the United States in 1916, at a time when the Department was exploring the field of research in industry in this country with a view to deciding on future Government policy, and he was one of the original members of the Electrical Research Committee formed by The Institution and the B.E.A.M.A. in 1917 and has served on the Council of the Electrical Research Association since that Association was founded in 1920. During the last war Dr. Fleming, at the request of the Admiralty, organized the Lancashire Anti-Submarine Committee, for which war work he received civil honours.

The Research Department at Trafford Park, under Dr. Fleming's direction, has developed from a department first devoted to serving the immediate requirements of an electrical factory to a department in which fundamental researches of many kinds are pursued in widely different scientific fields. Both to assist in this expansion and as a direct result of it, Dr. Fleming has always set the highest value upon co-operation with university research laboratories, and has sought to bridge the gap between the pure and the industrial research worker by affording the most generous facilities for interchange of staff and laboratory equipment. He gave great help to the Cavendish Laboratory in Dr. Kapitza's early experiments in the production of intense magnetic fields and in the high-voltage experiments which ultimately led to the amazing discoveries of Dr. Cockcroft and Dr. Walton in 1931 on atomic disintegration. Many members of Dr. Fleming's staff have been assisted to return to university life for a few years to qualify for senior degrees, and his laboratories have been opened to members of university staffs to pursue special experiments for which better facilities existed there than in their own laboratories. In pursuing this most liberal policy in the direction of his large department, Dr. Fleming has rendered signal service to the development of scientific research in many universities of the country as well as in his own laboratories, and he has properly been made a Doctor of Engineering *in honoris causa.* [The President then, amid applause, presented the Faraday Medal to Dr. A. P. M. Fleming.]

Dr. A. P. M. Fleming: I am deeply sensible of the great honour which in making this award The Institution has conferred upon me.

The President has referred, in terms which are more than generous, to certain engineering activities in which I have taken some part, in particular the training of personnel and the prosecution of research. These are activities also in which our Institution has always taken a most vigorous interest. I have been associated with The Institution since my student days and have exercised to the full the unrivalled opportunities which it affords as a platform for the expression of one's views and experiences, in an atmosphere of friendly and constructive criticism. It has been under these conditions and in the various offices of The Institution which I have been privileged to fill that I have had opportunities of taking a wider interest in these two problems of training and research than would otherwise have been possible.

These problems are of fundamental importance in any technical institution, but especially so in ours which is associated with an industry based on scientific discovery and is at every turn dependent on scientific research and the extent to which this is utilized by a highly technically-trained personnel. Those of us who are engaged in industry are well familiar with the loss in value due to depreciation and obsolescence of expensive plant and machinery. The young human machine provides a startling contrast, for with a little attention, encouragement and inspiration in the matter of education and training, its value and capacity are ever-expanding and limitless. Engineers who are concerned with the training of personnel must have experienced, as I have done, the greatest satisfaction and pleasure in seeing this growth of capacity and to see these young men enter the ranks of The Institution, grow in engineering stature and proceed upwards to full membership of The Institution, displaying increasing interest in the responsibilities of Institution affairs and in the progress of our industry.

I have been fortunate in having been concerned during the last 30 years with the research activities of a great engineering organization, and these have brought me into close association with the national developments that have taken place during this period for the scientific treatment and solving of problems fundamental to engineering and industrial progress. These facilities of so great an importance in war time may be of even greater significance in times of peace.

Our Institution is already considering in what directions it can be of assistance in helping to solve the industrial, economic, and social problems that the post-war period will bring. It is from the vast storehouse of undisclosed knowledge awaiting to be revealed by research workers and applied by engineers, and through the activities of a broadly educated and highly trained personnel, that the solution of many of the economic problems affecting our industry will come.

Again, Mr. President, I wish to express my grateful thanks to the Council and to this Institution for this award and to you for the kindly terms in which you made the presentation.

The President: I now have pleasure in presenting the Coopers Hill War Memorial Prize and Medal to Mr. John S. Forrest, M.A., B.Sc., for the paper submitted by him in the competition for the triennial award which fell to The Institution in 1940. [The President then, amid applause, presented the Prize and Medal.]

Dr. S. Chapman, F.R.S., then delivered the Thirty-Second Kelvin Lecture, entitled "Electrical Works by Helios, or the Sun and the Ionosphere," which will be published in a subsequent issue of the *Journal*.

Sir George Lee: It is with much pleasure that I propose a vote of thanks to Dr. Chapman for his very interesting lecture. Dr. Chapman is primarily a mathematician, and this work on geophysics is very largely a hobby of his. As you have gathered this afternoon, he has investigated by various means the constitution of the upper atmosphere, its temperature and its magnetic effects due to the millions of amperes which circulate in the very attenuated atmosphere many miles high, and he has given us some interesting pictures of the effects of the sun's radiation on wireless propagation, the so-called E and F layers.

I remember that about 10 years ago I presided at a meeting which consisted very largely of a debate between Dr. Chapman and Prof. Appleton on the effect of the sun on the upper atmosphere and on radio propagation. Dr. Chapman at that time advocated the consideration of the theory of corpuscular emission as a cause of the ionization of the upper atmosphere. Prof. Appleton, on the other hand, put forward ultra-violet radiation as the cause of the production of the ionized layers. I remember being very thrilled by Dr. Chapman's exposition of his particular theory, in which he showed that owing to the speed of the corpuscles there would be a difference of one or two hours in the time of the eclipse of the sun by the moon in the case of the corpuscles and that of the rays of light, and this effect would be shown in the observation of radio signals from a long distance. The time of the eclipse should form a means of distinguishing whether the production of the E and F layers was due to corpuscles or to ultra-violet radiation. Observations were made of the radio propagation during the next eclipse, but the results were somewhat indefinite. There is now an indication that both corpuscles and ultra-violet rays have an effect on the production of the E and F layers, but that the corpuscles have a considerably less effect than the ultra-violet rays.

The researches which Dr. Chapman is making on the upper atmosphere, together with the work done by other research institutions, are having a pronounced effect on radio engineering. They are gradually producing knowledge which is making for the exact propagation information that the radio engineer wants; he wants to be able to send a radio wave from A to B with full knowledge of the attenuating conditions and of the diverting conditions of the atmosphere. There is no doubt that the knowledge which Dr. Chapman and his associates are building up will form a very large part of the material for the cornerstone of the radio engineer's work; that is, the propagation of radio waves from one point to another.

The lecture we have just heard is known as the Kelvin Lecture, and Kelvin's contribution to engineering was, I think, principally the introduction of science into engineering. I think we can say with great cordiality that Dr. Chapman's lecture is very fully in phase with Kelvin's work, as it deals with the contribution of science to radio engineering.

Dr. P. Dunsheath: The annual Kelvin Lecture is becoming, I think, one of the most important and stimulating factors in raising and maintaining the intellectual level of this great Institution. On the present occasion it has been quite clear that not only the choice of the lecturer but his own selection of subject and the masterly way in which he has treated it commend themselves to all of us.

Sir George Lee has referred to Dr. Chapman as a man of international reputation in mathematical physics, but what pleases me more, having heard his lecture, is to find the way in which he has followed the spirit of Kelvin himself. Kelvin was, above all, an engineer, but with a much vaster knowledge of physics and mathematics than is possessed by most modern engineers. Further, I am interested to see what a train of coincidences there is in the lives of Kelvin and Dr. Chapman. In 1841, just 100 years ago, a fair-haired young man of 17, William Thomson, turned up at Peterhouse College, Cambridge, to start that most remarkable career in mathematical science which has never been surpassed. In 1941 we honour the memory of that man by a lecture from another who has added great lustre to the same university and the same science on very similar lines. In 1844 Kelvin was First Smith's Prizeman, and about 70 years later Dr. Chapman secured the same coveted award, and later both became Fellows of their colleges.

There are many reasons why we should consider ourselves fortunate in having listened to this lecture to-day and I have very great pleasure therefore in seconding the vote of thanks which has been proposed by Sir George Lee.

The vote of thanks was then carried with acclamation and the meeting terminated.

69TH ANNUAL GENERAL MEETING, 8TH MAY, 1941

Mr. J. R. Beard, M.Sc., President, took the chair at 4.20 p.m.

The notice convening the meeting was taken as read.

Messrs. E. H. Miller and L. B. S. Golds were appointed scrutineers of the ballot for the election and transfer of members, and, at the end of the meeting, the President reported that the members whose names appeared on the list (see page 210) had been duly elected and transferred.

The Premiums (see page 207) awarded by the Council for papers during the session were announced by the President.

The President next gave a summary of The Annual Report of the Council for the year 1940–41 (see page 213), in the course of which he mentioned that since the Report was completed the Council had decided to set up an Installation and Utilization Section of The Institution and that arrangements for its formation were already in progress.

The President then moved the adoption of the Report, and the motion was seconded by **Mr. L. W. Phillips,** who endorsed the Council's exhortation to those Associate Members who are qualified, to apply for transfer to full membership with a view to taking their proper place in The Institution.

In commenting on the Report **Mr. Phillips** suggested that whilst of necessity it had been impossible to hold many meetings during the winter, the Council should consider the practicability of extending the Institution's session. He further suggested reconsideration by the Council of the charge made for Parts II and III of the *Journal*, and a study of the changes that were taking place in education. In most of the technical colleges throughout the country there were, he said, thousands of young men from the Army personnel who were being trained and an attempt was being made to give them in about 4 months the training which would ordinarily take some years. In order that that might be done, educational methods and appliances and the whole curriculum were being re-organized.

The President thanked Mr. Phillips for his suggestions, which, he said, would be carefully considered.

The motion for the adoption of the Report was then carried unanimously.

Mr. E. Leete (*Hon. Treasurer*), in submitting the Annual Accounts for 1940,* said: "I expect that members will have noticed that shillings and pence have been omitted from the printed copy of the Accounts; this is in line with contemporary practice. Further, the Scholarship Fund Accounts have been altered to a more convenient and readable form.

"In submitting the Annual Accounts for 1939 my predecessor had occasion to draw attention to certain items of expenditure arising in that year which had increased the total amount expended by some £4 000 as compared with the previous year. From the present figures, and especially by reference to the Revenue Account, it will be seen that the outgoings of 1940, the first full war year, have been reduced by £6 816 compared with 1939. From the financial point of view this is satisfactory. Some of the reduction has been occasioned by the absence of certain non-recurring items, such as the net cost of publishing 'The History of The Institution,' amounting to £1 129, and £211 for printing the new edition of the Ship Wiring Regulations.

"The Council have throughout the year, in considering the activities of The Institution, necessarily given very close attention to the financial aspect. All items of expenditure have been very carefully considered by the Finance Committee, as will be apparent by a closer examination of the Revenue Account.

"Taking the first two headings on the Expenditure side of that Account, it will be seen that the higher cost of the Institution building is more than offset by the savings on Management. This higher cost is due mainly to a heavy increase of £530 in the rates, and to the operation of the Coal Clause in our heating agreement, which has caused an increase of £370. There may be a further increase in both these items, unfortunately, in next year's Accounts.

"There is a saving of £1 686 in the cost of Air-Raid Precautions; £750 of this represents the Government grant and our tenants' share in the cost of the shelter which was erected in 1939. In considering this item, however, it is as well to take the two years together, for the average is an indication of the cost that should be faced while the war continues. The curtailment of meetings and the restricted programme of activities in the provinces has resulted in a lower cost for Meetings and for Local Centres of £412 and

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* See page 226.

£1 943 respectively. Scholarships are some £200 lower owing to present conditions; that is a temporary saving only. The Annual Dinner and Conversazione were abandoned, and that has resulted in a saving of £825.

"The Income side of the Revenue Account shows that our income for the year was £58·310, which is practically the same as in the preceding year. I hope it will be agreed that in the existing conditions this is a most reassuring sign, particularly as the revenue from subscriptions has exceeded that of last year. The amount carried to the Balance Sheet is £10 975, as against £4 184 in 1939, an increase of £6 791.

"Turning to the Balance Sheet, it will be seen that Depreciation of £359 has been set off against the amount of £10 975, and that the Surplus of Assets over Liabilities now stands at £233 968, an improvement on the year of £10 616. This compares with £3 063 in the preceding year.

"The investment policy of the Council during the past year has been directed towards helping the Government's war effort. The last three items in the list of Investments show that, in addition to subscribing to two of the new war issues, £2 000 was lent to the Treasury free of interest. I am pleased to be able to announce that since the close of these Accounts a further £8 000 has been invested in 3 % Savings Bonds, and by the exercise of every economy further investments of this nature should be made before this time next year.

"The market value of the Investments at the 31st December, 1940, was £168 632, compared with a book value of £151 434, an appreciation of more than £17 000. The Investments were again valued at the end of April, and it was found that their market value had appreciated by a further £1 500.

"Appearing above Investments there is an item 'Special Suspense Account £1 002.' This is the amount which we have had to expend during the year on temporary repairs to the building. We hope that we shall in due course receive a refund of this amount from the Government, and consequently the amount has not been written off.

"I feel sure members will agree that the Accounts show that the Institution's finances are in a very sound and healthy condition.

"I should like to add a few words on the subject of the *Journal*. The amount of paper available is extremely limited and it is absolutely essential that the circulation of Parts II and III should be restricted to those who really want them. I am afraid the only practical way of doing that is to make a slight charge, for there is not sufficient paper at our disposal to allow us to issue the whole of the *Journal* free to the members.

"In conclusion I would express my sincere thanks for the help that has always been given to me by the staff of The Institution whenever I have wanted information. I now move: 'That the Statement of Accounts and the Balance Sheet for 1940 as presented be received and adopted.' "

The motion for the adoption of the Accounts was seconded by **Mr. B. Binyon** and was carried unanimously.

The President: I now have much pleasure in proposing "That the best thanks of The Institution be accorded to the following officers for their valuable services during the past year: (*a*) the Honorary Secretaries of the Local Centres and Sub-Centres and the Local Honorary Secretaries abroad; (*b*) the Honorary Treasurer (Mr. E. Leete)." I think that no one except the Secretary sees more than the President of the very extensive, useful and, at the same time, unobtrusive work done by the Honorary Secretaries of the Local Centres and by the Local Honorary Secretaries abroad, and I consider this to be an occasion on which The Institution ought to let them know how much their work is appreciated. As regards the Honorary Treasurer, we are delighted to have him back in office and I am sure we all wish to thank him very much for the valuable work he has done.

The resolution was carried with acclamation.

Mr. J. F. Shipley then moved "That Messrs. Allen, Attfield and Co. be appointed auditors for the year 1941–42." The motion was seconded by **Mr. F. C. Knowles** and was carried unanimously.

The meeting then terminated.

THE BENEVOLENT FUND

43RD ANNUAL GENERAL MEETING, 8TH MAY, 1941

Mr. J. R. Beard, M.Sc., President, took the chair at 5.15 p.m.

The notice convening the meeting was taken as read.

The minutes of the 42nd Annual General Meeting, held on the 9th May, 1940, were also taken as read and were confirmed and signed.

The Report of the Committee of Management (see below) and the Statement of Accounts for the year 1940 (see page 240), were presented and, on the motion of the Chairman, seconded by Mr. W. C. P. Tapper, were unanimously adopted. The Chairman proposed, and it was unanimously resolved, that Mr. A. J. Attfield, F.C.A., be elected Honorary Auditor for the year 1941.

The Chairman reported the constitution of the Committee of Management for the year 1940–41 as follows:—

The President (*Chairman*).

The Rt. Hon. The Viscount Falmouth	representing the Council.
F. Gill, O.B.E.	
Prof. R. O. Kapp, B.Sc.	
Sir George Lee, O.B.E., M.C.	
C. W. Marshall, B.Sc.	
A. P. Young, O.B.E.	
J. R. Cowie	representing the contributors.
J. H. Johnson	
H. Marryat	

And the Chairmen of the Local Centres in Great Britain and Ireland.

The meeting then terminated.

REPORT OF THE COMMITTEE OF MANAGEMENT OF THE BENEVOLENT FUND FOR 1940

Capital

The Capital Account stood on the 31st December, 1940, at £26 909, which is invested. A transfer of £3 046 from Income to Capital was made during 1940.

Receipts

The Income for 1940 from dividends, interest and annual subscriptions, was as follows:—

Dividends and Interest	£1 069
3 806 Annual Subscriptions	1 799
	£2 868

Donations

In addition to the foregoing, the Fund benefited during the year by the following subscriptions and donations:—

	£	s.	d.
Mersey and North Wales Centre:			
Electrical Engineers' Ball	92	15	2
Collection in lieu of Golf Tournament	73	4	10
North-Western Centre: collection in lieu of Golf Tournament	90	0	0
"The Twenty-Five Club"	52	10	0
Western Centre, and West Wales Sub-Centre: collections at meetings	18	4	2
Incorporated Municipal Electrical Association	10	10	0
National Register of Electrical Contractors	10	10	0
North Midland Centre:			
Collection at meetings	9	6	0
Collection in lieu of Annual Dance	6	14	6
North-Eastern Students' Section: Annual Dance	5	0	0
Henley's Telegraphy Works Co., Ltd.	25	0	0
Messrs. Merz and McLellan	15	15	0
Standard Telephones and Cables, Ltd.	5	5	0
H. Marryat	*191	6	1
Lord Hirst of Witton	30	0	0
G. H. Nisbett	*21	17	5
E. Fawssett	*16	3	1
B. Price	*15	7	8
W. C. P. Tapper	11	1	0
Anonymous	10	10	0
C. L. Fortescue	10	5	0
H. Williams	10	0	0
H. W. Kolle	*9	13	10
S. B. Donkin	*8	1	6
A. P. M. Fleming	*8	1	6
F. Gill	*8	1	6
P. Rosling	*8	1	6
H. T. Young	*8	1	6
D. R. McLagan	6	7	6
W. Hahn	6	6	6
C. L. Lyons	6	6	0
W. H. Nottage	6	6	0
Anonymous	5	17	0
V. E. Faning	5	5	0
Sir Archibald Page	5	5	0
S. H. Pook	5	5	0
P. J. Robinson	5	5	0
E. Thomas	5	5	0
L. C. F. Bellamy	5	0	0
J. M. Donaldson	5	0	0
J. M. Kennedy	5	0	0
R. G. Kilburne	5	0	0
E. A. Short	5	0	0
K. A. Scott Moncrieff	5	0	0
and 2 790 donations of under £5	971	10	2
	£1 840	4	5

* Includes amount recovered from Income Tax Authorities.

Legacies

The Fund has benefited during the year by two legacies of £100 each, one from the late Mr. Ll. B. Atkinson (Past-President) and one from the late Mr. F. W. Bridges.

Income

The total income from all sources for 1940 was £4 909, which compares with £5 291 for 1939.

Grants

Applications for assistance were made by or on behalf of 84 persons during 1940, and the Committee, after careful consideration, made grants in all the cases. In assisting these persons the Fund also provided for the necessities of 63 dependants.

The total amount of the grants were £3 952, which compares with £3 815 in 1939.

Donors and Subscribers

Owing to shortage of paper and for reasons of economy, a list of contributors was not published in 1940, but this will be resumed as soon as conditions permit.

Local Honorary Treasurers

The Committee wish to express cordial appreciation to Local Honorary Treasurers for their untiring efforts in stimulating an interest in the Fund among the members in the Local Centres, and for their valuable help in the investigation of applications for assistance.

Refund of Income Tax

The Fund is able, under the provisions of the Finance Act, 1922, to recover income tax on annual subscriptions, provided the subscribing member signs a deed of covenant to give a fixed amount per annum for a minimum period of 7 years.

The wording of the deed provides for the covenant to terminate on the death of the subscriber, and does not involve executors in any liability.

A number of contributors (approximately 200) have already agreed to subscribe under this arrangement, and if any other member wishes to subscribe under the scheme the Honorary Secretary of the Fund will be pleased to supply him with the necessary form and particulars.

Wilde Fund

The Capital Account stood, on the 31st December, 1940, at £5 050, all of which is invested and brings in an annual income of about £104.

The balance standing to the credit of the Income Account (from which, under the Trust Deed, only full Members and their dependants can benefit) on the same date was £88.

Grants amounting to £100 were made from this Fund during the year.

The Income of this Fund is administered by the Committee of Management of the Benevolent Fund, and its Accounts are published in the *Journal*.*

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* See page 231.

THE BENEVOLENT FUND OF
THE INSTITUTION OF ELECTRICAL ENGINEERS

INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR 1940

DR. EXPENDITURE.

Year ended 31 Dec., 1939. £		£
3,815	To Grants	3,952
35	„ Printing, Stationery, Postage, etc.	39
1,441	„ Unexpended Balance carried to Balance Sheet	918
£5,291		£4,909

INCOME. CR.

Year ended 31 Dec., 1939. £		£	£
1,111	By Dividends and Interest		1,069
241	„ London Electrical Engineers' Ball		nil
	„ Donations of £5 and over:—		
	Mersey and North Wales (Liverpool) Centre:—		
	Collection in lieu of Golf Tournament	73	
	Electrical Engineers' Ball	93	
	North-Eastern Centre, Students' Dance	5	
	North Midland Centre:—		
	Collections at Meetings	9	
	Collection in lieu of Electrical Engineers' Ball	7	
	North-Western Centre, Collection in lieu of Golf Tournament	90	
	Western Centre and West Wales Sub-Centre, Collections at Meetings	18	
	Other donations	574	
1,170			869
1,117	„ Donations under £5		972
1,652	„ Annual Subscriptions		1,799
nil	„ Legacies:—		
	From the late Mr. Ll. B. Atkinson	100	
	From the late Mr. F. W. Bridges	100	
			200
£5,291			£4,909

BALANCE SHEET, 31st DECEMBER, 1940

LIABILITIES.

	£	£
Capital Account:—		
As per last Balance Sheet	23,863	
Amount transferred from Income and Expenditure Account in 1940	3,046	
		26,909
Income and Expenditure Account:—		
As per last Balance Sheet	6,403	
Unexpended Balance in 1940	918	
	7,321	
Profit on redemption of £500 New Zealand 3½ % Stock (1940)	13	
	7,334	
Less Loss on redemption of £1,000 4½ % Conversion Stock (1940–44)	54	
	7,280	
Less Amount transferred to Capital Account in 1940	3,046	
		4,234
Sundry Creditors		2
Subscriptions and Donations received in advance		10
		£31,155

ASSETS.

		£
Investments (Capital), at cost:—		
£961 7s. 7d. Cape of Good Hope 3 % Stock (1933–43)		950
£420 London and North Eastern Railway 4 % First Preference Stock		504
£450 London, Midland and Scottish Railway 4 % Debenture Stock		551
£750 East Indian Railway 3½ % Debenture Stock		738
£300 London, Midland and Scottish Railway 4 % Guaranteed Stock		334
£487 4s. 9d. 3 % War Stock (1955–59)		487
£5,800 3½ % War Stock		5,783
£350 New South Wales 4 % Stock (1942–62)		337
£2,580 4 % Funding Stock (1960–90)		2,124
£3,295 3½ % Conversion Stock (1961)		2,513
£450 Commonwealth of Australia 5 % Stock (1945–75)		439
£450 Tynemouth Corporation 5 % Stock (1947–57)		457
£950 Agricultural Mortgage Corporation 5 % Debenture Stock (1959–89)		988
£1,000 Southern Railway 5 % Redeemable Guaranteed Preference Stock (1957)		1,028
£1,000 Southern Railway 5 % Guaranteed Preference Stock		1,000
£1,000 Hastings Corporation 5 % Stock (1947–67)		980
£800 London Passenger Transport Board 5 % "A" Stock (1985–2023)		808
£700 Ayr County Council 5 % Stock (1947–57)		733
£1,000 Commonwealth of Australia 4 % Stock (1955–70)		1,013
£900 South Essex Waterworks Co. Perpetual Debenture 4 % Stock		1,014
£1,700 London County Council 2¾ % Consolidated Stock (1960–70)		1,581
£1,050 Newcastle and Gateshead Water Co. 5 % Consolidated Preference Stock		1,514
£1,000 3 % Funding Stock (1959–69)		1,033
(*Market value* 31*st December*, 1940, *£28,149*.)		£26,909
Investments (Income) at cost:—		
£1,512 15s. 3d. 3 % War Stock (1955–59)	£1,512	
£1,000 3 % Defence Bonds	1,000	
£1,000 2½ % National War Bonds (1945–47)	1,000	
		3,512
(*Market value* 31*st December*, 1940, *£3,530*.)		
Sundry Debtors		105
Cash:—		
At Bank	£627	
In hands of Honorary Secretary	2	
		629
		£31,155

I have audited the above Balance Sheet and Income and Expenditure Account with the Books and Vouchers and certify them to be correct, and have verified the Investments with Certificates from Banks.

10th April, 1941.

ARTHUR J. ATTFIELD, F.C.A.,
Honorary Auditor.

ABSTRACTS OF PAPERS

THE LIGHTNING DISCHARGE

By C. E. R. Bruce, M.A., B.Sc., and R. H. Golde.

(Abstract *of a paper which will be published in December, in Part II of the Journal.*)

Introduction

In the course of a study of the characteristics and the mechanism of the lightning discharge it became evident that there exists a large amount of relevant data, obtained in many parts of the world by different methods of investigation, but that the implications of these data are by no means consistent. No emphasis had previously been laid on this inconsistency and no attempt made to remove it. In the present work a complete synthesis of all these data has been effected, involving the rejection of some and the revaluation of others.

Time Characteristics of the Lightning Flash

The multiple nature of the lightning discharge has long been known, a complete *flash* often comprising several successive *strokes*, each one following the path of the first stroke in every detail. Each stroke is initiated by a leader stroke which makes its way relatively slowly from cloud to earth. On making contact with the earth it is followed by the intense upward return stroke, which is the part of the phenomenon of greatest interest to the engineer.

A more detailed study enables frequency distributions of the various time characteristics to be prepared. Thus, as regards the number of strokes per flash, it is found that about half the total number of flashes consist of only one stroke, while flashes comprising 2, 3, 4, etc., strokes occur with steadily decreasing frequency. The average and maximum numbers of strokes per flash, together with the percentage of multiple-stroke flashes, as observed in South Africa, Russia, Japan and the U.S.A., are shown in Table 1. Values applicable to this country were derived by the authors from records of "atmospherics" obtained by the Radio Research Board and agree well with the remainder of the data.

McEachron's data, which were obtained from oscillographic records of the operation of expulsion tubes on a 138-kV line in the U.S.A., indicate much lower values than the rest of the data, but this is understandable since the weaker strokes would fail to cause flashover of the gaps in the expulsion tube.

For the total duration covered by the complete flash (Table 1) the data obtained in Russia again show good agreement with those obtained by the authors from the Radio Research Board's records, but McEachron's values are again very low. This fact, taken in conjunction with the reduced number of strokes per flash found by him, shows that it is the later strokes which have failed to cause flashover of the expulsion gaps, and it can therefore be concluded that the later strokes of a flash are the weaker.

This conclusion is confirmed by the agreement of his data on the time intervals between strokes with those found elsewhere (Table 1), which again show satisfactory agreement among themselves.

The only results which disagree completely with this great and consistent body of data are those obtained by Norinder. Having come to the conclusion early in his investigation that the total duration of a flash was about one-hundredth of a second, which (see Table 1) is only about 1% of the true value, he uses an oscillatory time scale giving one sweep in about 1½ hundredths of a second.

Table 1

Characteristics of Lightning Flashes

Investigator	Country	Number of flashes	Percentage of multiple strokes	Number of strokes in a flash		Number of flashes	Total durations of flashes (sec.)		Number of strokes	Time intervals between strokes (sec.)	
				Mean	Max.		Mean	Max.		Mean	Max.
Schonland and others . .	South Africa								230	0·045	0·17
Schonland and others . .	South Africa	65	51	3·4	27				109	0·063	0·53
Stekolnikov and Valeev	Russia	25	72	3·0	12	25	0·27	1·2	76	0·107	0·6
Stekolnikov	Russia					—	0·27	1·1	—	0·073	0·5
McEachron	U.S.A.	184	28	1·7	12	184	0·09	0·7	125	0·085	0·43
Noto	Japan	235	46	2·3	20						
E.R.A., from Radio Research Board records	Great Britain	108	54	2·6	11	108	0·18	1·1	179	0·095	0·4

It is therefore evident that the values he obtains for time intervals between strokes and total durations of flashes are not determined by the phenomena themselves but only by his time scale, and are therefore meaningless.

MECHANISM OF THE LIGHTNING FLASH

Current Magnitude.

The distributions of current magnitudes in strokes to transmission lines, as recorded in different parts of the world by means of magnetic links, are also found to be in very good agreement (Fig. 1), about half the total number of flashes having values greater than 20 000 amperes in each case.

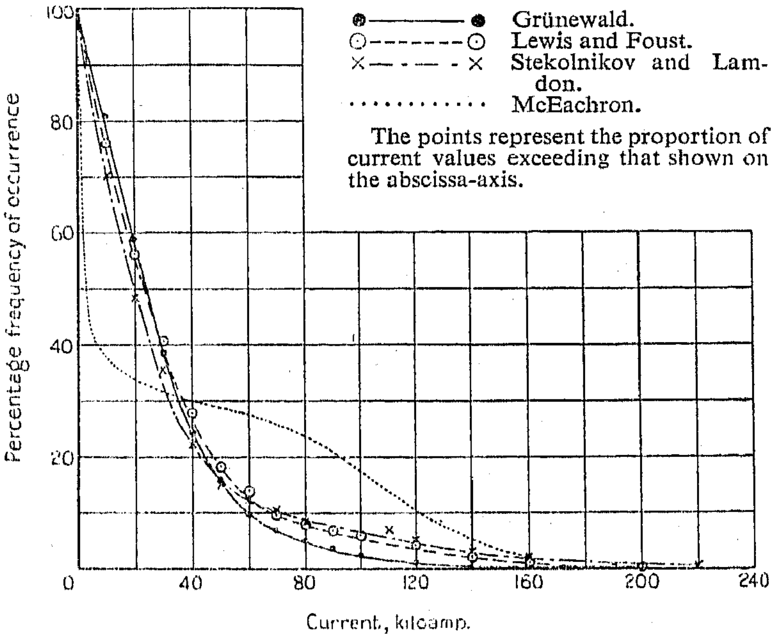

Fig. 1.—Currents in lightning flashes to transmission lines and to Empire State Building.

Norinder also gave a distribution of currents calculated from records of the magnetic field due to nearby flashes to open country, and both he and others emphasized the agreement between his own and the magnetic link data. In so doing they overlook one most important difference between the two sets of data, for whereas the magnetic link records only the maximum current in the flash, Norinder calculates the currents in individual strokes. The link data should thus show quite decidedly higher values than Norinder's results. However, it will be shown later that Norinder's calculation is vitiated by several errors.

McEachron has given a distribution of currents in flashes to the Empire State Building (Fig. 1) showing a high proportion of very high values. He, however, has made a very similar mistake to Norinder's, in that he has overlooked the fact that a varying number of flashes up to 19 struck the building while any one set of links was in place.

The data on the currents are thus reduced to the transmission line data, with an average value of about 20 000 amperes. Calculations of the various fields caused by such an average current will be shown to agree with the observed values.

Current Wave-form.

During the progression of the leader stroke towards the earth a portion of the charge from the cloud is lowered along this conducting channel. The distribution of this charge will vary with the capacitance of the channel, and will therefore be greatest near the earth and decrease steadily from earth to cloud. This charge distribution explains the well-known tail of the lightning surge. Furthermore, the charge along the leader stroke will not be contained in a thin filament but will spread horizontally by a corona effect. Just as this will occur gradually during the leader stroke process, so neutralization of this charge will not occur instantaneously during the return stroke. Consideration of this process in association with the distribution of charge up the channel and the velocity of the return stroke enables the wave-form of the lightning current, which had not hitherto been explained to be calculated. Fig. 2 shows the good agreement between the calculated waves (*a*) and (*b*) and that observed (*c*), two limiting conditions being assumed for the charge distribution.

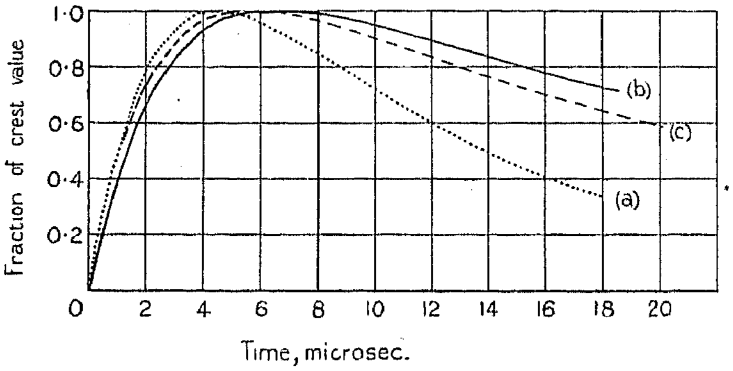

Fig. 2.—Calculated and observed lightning current wave-shapes.

The return stroke must therefore now be regarded as a varying current flowing in a conductor of ever-increasing length. This important point has been overlooked by previous investigators, such as Norinder and others, who assumed a constant current throughout the whole length of the lightning channel at any instant, which leads of necessity to wrong values for the current magnitude. This is only one of two or three errors committed by Norinder in this calculation, so that his data on lightning currents are also valueless as they stand.

The new picture, however, admits of the calculation of the magnetic field due to near strokes, as well as the radiation field, observed at greater distances in the form of atmospherics, and good agreement is found between calculated and observed values (see, for example, Table 2).

TABLE 2

Variation with Distance of Radiation Field due to Lightning Stroke

Distance, km.	50	100	175	350
ϵ_r calculated (*V/m*)	5·4	2·7	1·5	0·8
ϵ_r observed (*V/m*)	5·0	1·7	0·8	0·3

After the return stroke has reached the cloud charge—that is in about 100 microseconds—quite considerable currents—of the order of 1 000 amperes—continue to flow in many strokes for times of the order of 2 or 3 milliseconds. The current in a stroke is thus shown in Fig. 3, in which (*a*) represents the current flowing to earth while the charge along the leader-stroke channel is neutralized, and (*b*) shows the full wave, the long tail representing the flow to earth of the remainder of the charge in the first charge centre in the cloud which originated the flash.

Schonland considers that the channel then becomes "dead" and "inactive" (Fig. 4) while new leader strokes proceed from other charge centres in the cloud to the original channel. However, between the successive strokes of a flash a considerable field still exists due to the charge still remaining near the bottom of the cloud and, as the channel is thoroughly conducting, this will cause it to become positively charged and to act as a long pointed conductor which will initiate streamers away from the channel towards the other charge centres. This means that during the interval between strokes a small current continues to flow. This current, since it was not observed by McEachron, must be below the limits of his apparatus, i.e. less than 20 amperes, but its occurrence was deduced from several considerations and final photographic corroboration has been obtained by McEachron since the paper was written. This conception of the low-current background on which a series of waves already described are superimposed, then completes the picture of the current wave during a flash.

Charge Neutralized during Stroke and Flash.

Integration of the oscillograms shown in Fig. 3 indicates that for an average stroke the charge lowered during the first or surge period is of the order of 0·5–1·0 coulomb. In the case of a surge travelling along a line the charge will, of course, be much less than this, the maximum possible surge current even in the case of a 132-kV line being only about 4 000 amperes.

The charge in the complete stroke, obtained by integrating curve (*b*), is about 8 or 9 coulombs and, as there are on an average between 2 and 3 strokes, the average charge in a flash will be about 20 coulombs.

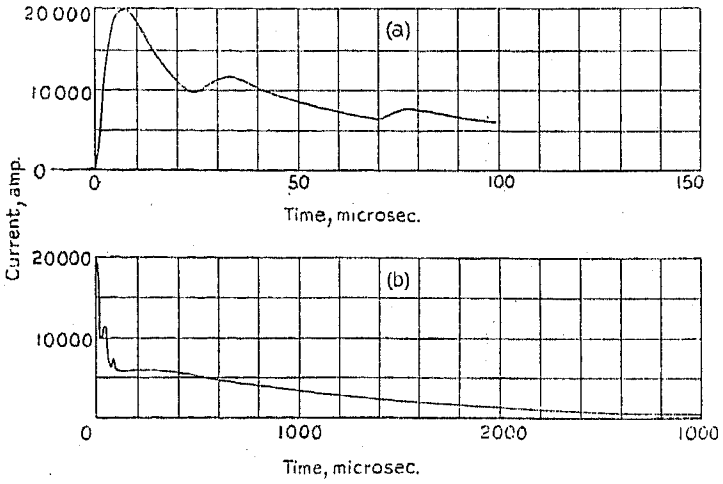

Fig. 3.—Current wave in lightning channel.

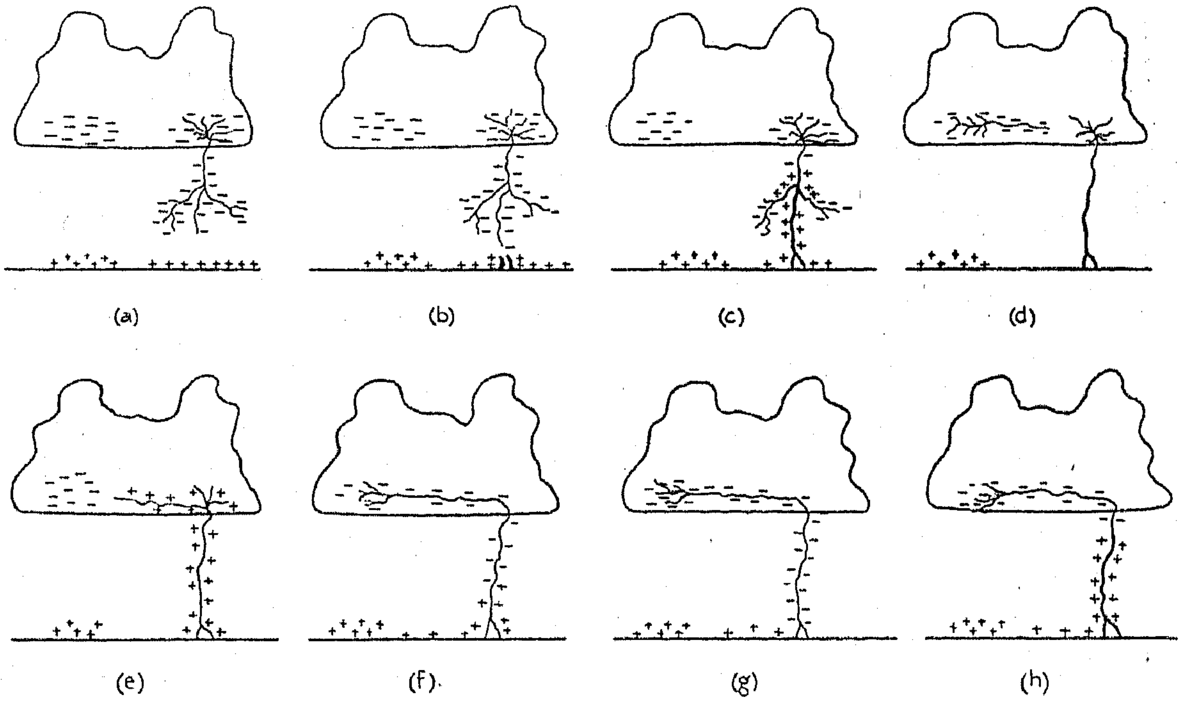

Fig. 4.—Diagram illustrating leader and return strokes to first and subsequent strokes. (*a*) to (*d*) Schonland. (*a*) to (*c*) and (*e*) to (*h*) sequence described herein.

McEachron, by integrating oscillograms of flashes to the Empire State Building, obtained an average value of about 40 coulombs for the charge in a flash. However, these were initiated by upward leader strokes from the building, so that McEachron records the charge in the cloud *plus* the space charge neutralized *en route*, whereas the above estimate represents the cloud charge *minus* the space charge neutralized *en route*. This leads to the conclusion that the average charge on the cloud was about 30 coulombs, of which about 10 are neutralized in the intervening space. Support for these values of cloud and space charge is derived from the agreement between the calculated and observed electrostatic field changes near a lightning flash.

Potentials developed in Thunderclouds.

Wilson's estimate of the potential of a thundercloud was based on the conception of a charge of 20 coulombs concentrated in a sphere of about $\frac{1}{2}$ km. radius. It has, however, been shown that the charge comes to earth in a series of strokes, and from the time intervals between these strokes and the velocity of the leader stroke process the area originally covered by the charge destroyed in one flash must be of the order of 100 km^2. With a condenser of this size the potential difference, even with a charge of 30 coulombs, is only about 8×10^7, as compared with Wilson's estimate of 1×10^9 to 6×10^9 volts, that is a field between cloud and ground of the order of a few hundred volts per centimetre instead of at least 10 000 volts per centimetre, a value which has never been observed even in balloon ascents through thunderclouds.

From the fact that very high structures like the Empire State Building initiate upward leader strokes, it appears that the condition for a flash is not the occurrence of a uniform high field, but a sufficiently intense concentration in a comparatively small uniform field. In the cloud this field concentration may be caused by the mechanical elongation of volumes of space charge.

Polarity of Lightning Flashes

The data available on the polarity of lightning discharges show clearly a very high preponderance, about 17:1, of negative over positive flashes in tropical and sub-tropical regions as compared with the ratio of about 3:1 found for temperate regions. There is also a greater preponderance of negative to positive flashes to tall earthed structures as compared with the ratio in flashes to open country in the same region. The latter effect is due to the occurrence of positive streamers from the tall structures, which attract a higher number of negative leader strokes.

The polarity distribution of direct strokes to the phase wires of a transmission system can be shown to differ from that of strokes to the earthed parts of the system, but to be similar to that of strokes to open country, since the positive streamers do not arise from the insulated conductors as they do from the earthed parts. It was also found that positive currents are on an average greater than negative, particularly in the higher current ranges.

Lightning Surges on Transmission Lines

The most frequent surges due to lightning effects are those induced by strokes to earth. These will hardly ever exceed a voltage of about 200 kV, a value which is only dangerous on medium- or low-voltage lines. These voltages have often been observed and the multiple nature of the surges confirmed.

In the case of a stroke to a tower or earth wire the voltage set up by the lightning current in the tower impedance may be sufficiently high to cause a back-flashover of one or more insulator strings. This will lead to a very steep-fronted surge of amplitude equal to the flashover voltage of the insulator string and a tail given by the *IR* drop. If this earth fault is not interrupted by external means, apparatus will be subjected to the full sequence of surges due to the subsequent strokes.

Direct strokes to phase wires may or may not result in flashover, according to whether the product of current times the line surge impedance is greater or less than the flashover voltage of the insulators. Surges resulting from flashover will have the normal front with a very steep back—this portion being very rapidly attenuated—followed by the long tail represented by the current times the impedance of the path to earth, which may in this case be quite small.

If no flashover occurs, the stroke must have been a weak one, and there is thus little likelihood of subsequent strokes in this case. This suggestion is important because of the effect which subsequent strokes will have on apparatus in this case, but no available data disprove it.

It is thus seen that apparatus in the field may be subjected to a sequence of surges at intervals of a few hundredths of a second, together with the intervening low current. The question therefore arises whether, under these circumstances, testing by the application of a simple surge of standard form, as at present carried out, is adequate.

DIELECTRIC LOSS IN THIN FILMS OF INSULATING LIQUIDS

By C. G. Garton, Associate Member.*

(Abstract *of a paper which was published in March in Part III, and in April in Part II of the Journal.*)

Introduction

It has often been observed that porous materials impregnated with an impure liquid dielectric possess a dielectric-loss angle which varies greatly with the applied stress, especially with low values of the latter at which ionization by stress cannot be present.

The nature of the effect may be seen from Fig. 1, which shows loss angle plotted against voltage for two paper condensers impregnated with impure polychlordiphenyl (liquid of the Pyranol type) and from Fig. 4 which gives similar curves for a thin (0·03 mm.) film of trichlorbenzene between plane metal electrodes. The points indicated in these figures refer to theoretical results to be given later.

It will be seen (most clearly from Fig. 4) that the loss angle rises with the stress for low values of the latter, passes through a maximum, and thereafter falls sharply with increasing stress. Although the decrease in loss angle has been attributed qualitatively to the motion of ions impeded by the cellular structure of the paper, the existence of a maximum in the curves has until now remained unexplained, nor has the effect been previously reported for films of liquid alone, without the presence of a solid dielectric.

Since the effect can, under some conditions, change the loss angle of a given dielectric by a factor as great as 10 to 1, it seemed worthy of thorough investigation. It has proved possible to obtain the effect under controlled experimental conditions, and, further, to predict mathematically the shape of the curves obtained, so placing the subject upon a quantitative basis.

The scope of the paper includes:—

(1) An approximate theory of the energy losses in a dielectric containing ions the motion of which under an alternating field is impeded by solid barriers.

(2) An experimental investigation of the dielectric loss of very thin films of insulating liquid, to check the conclusions of the foregoing theory.

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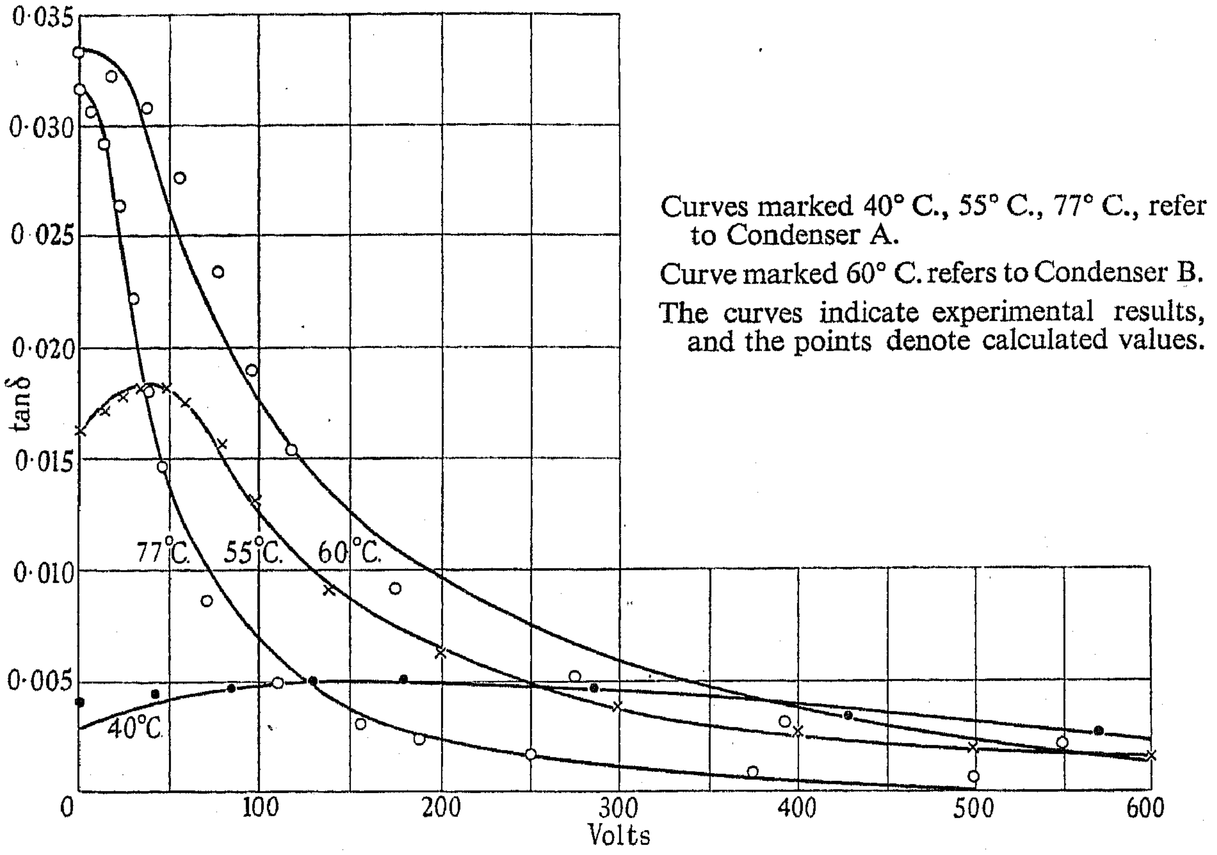
* British Electrical and Allied Industries Research Association.



Curves marked 40° C., 55° C., 77° C., refer to Condenser A.
Curve marked 60° C. refers to Condenser B.
The curves indicate experimental results, and the points denote calculated values.

Fig. 1

(3) An application of the theory to experimental results upon impregnated condensers.

Theory of Ionic Motion in Thin Films

The purpose of this section is to develop a theory of the dielectric loss of liquids in which the motion of ions in an alternating field is impeded by the presence of solid boundaries.

When dielectric loss is measured on a liquid in bulk (i.e. with an electrode spacing much greater than the amplitude of oscillation of the ions in the field) the loss angle remains approximately constant with increasing stress up to a stress sufficient to cause ionization by collision, when the loss angle increases and breakdown ensues. For many applications, however, the liquid is used as an impregnant within the pores of a solid dielectric. The pores are of dimensions comparable with the oscillations of the ions at a reasonable field strength, and the walls of the pores form barriers limiting the motion of the ions to less than their amplitude in the liquid in bulk. Under these conditions the loss angle is no longer independent of the applied field, but varies in the manner already described.

Neglecting any polar loss (which will result in an angle independent of the field) we assume that the dielectric loss of the liquid is due to the presence of molecules of impurity which are dissociated to an extent depending upon temperature and other conditions. If such a liquid exist within a sufficiently small pore of a solid dielectric (or between two closely adjacent electrodes, provided that the ions do not recombine on the surface of these), two main effects of the applied alternating field are to be expected:—

(*a*) A decrease of loss angle above a certain voltage, because the ions are not free to perform oscillations larger than the dimensions of the pore.

(*b*) An increase in the number of free ions, with increase in voltage, because the field, by segregating ions of opposite sign, will lower the rate of recombination while leaving the rate of creation of new ions unaltered.

It will be seen that these two effects suffice to explain the existence of a maximum value of the loss angle, followed by a decrease.

Subject to a number of simplifying assumptions, the effect of (*a*) is shown to be given by

$$\tan\delta = (1/\pi)(\theta - \sin\theta\cos\theta)\tan\delta_0 \quad . \quad . \quad (1)$$

where

$\tan\delta$ is the loss angle at any stress $A\sin\omega t$;
$\tan\delta_0$ is the loss angle at a stress $A_0\sin\omega t$ just sufficient to give the ions a double amplitude equal to the width of the pore;
$\theta = \arccos(1 - 2A_0/A)$.

Subject again to various assumptions, of which the most important is neglect of forces upon the ions other than those directly due to the applied field, the effect of (*b*) may be included by multiplying equation (1) by a factor

$$q = \frac{-Q + \sqrt{[Q^2 + 4(s-1)sQ]}}{2(s-1)} \quad . \quad . \quad (2)$$

where $s = \dfrac{\text{concentration of ionizable molecules}}{\text{concentration of ions}}$

and Q is one of three functions of A/A_0, according to the numerical range of the latter, for which the full paper should be consulted. Values of $(q/\pi)(\theta - \sin\theta\cos\theta)$ as a function of s and A/A_0 are shown in Fig. 2.

Three equations are derived by means of which the ionic concentration, mobility and radius may be calculated from experimental data of the maximum loss angle and the stress at which it occurs. These are:

The concentration, $N_1 = \dfrac{\kappa A_0 \tan\delta_{max}}{4\pi de} \quad . \quad . \quad . \quad (3)$

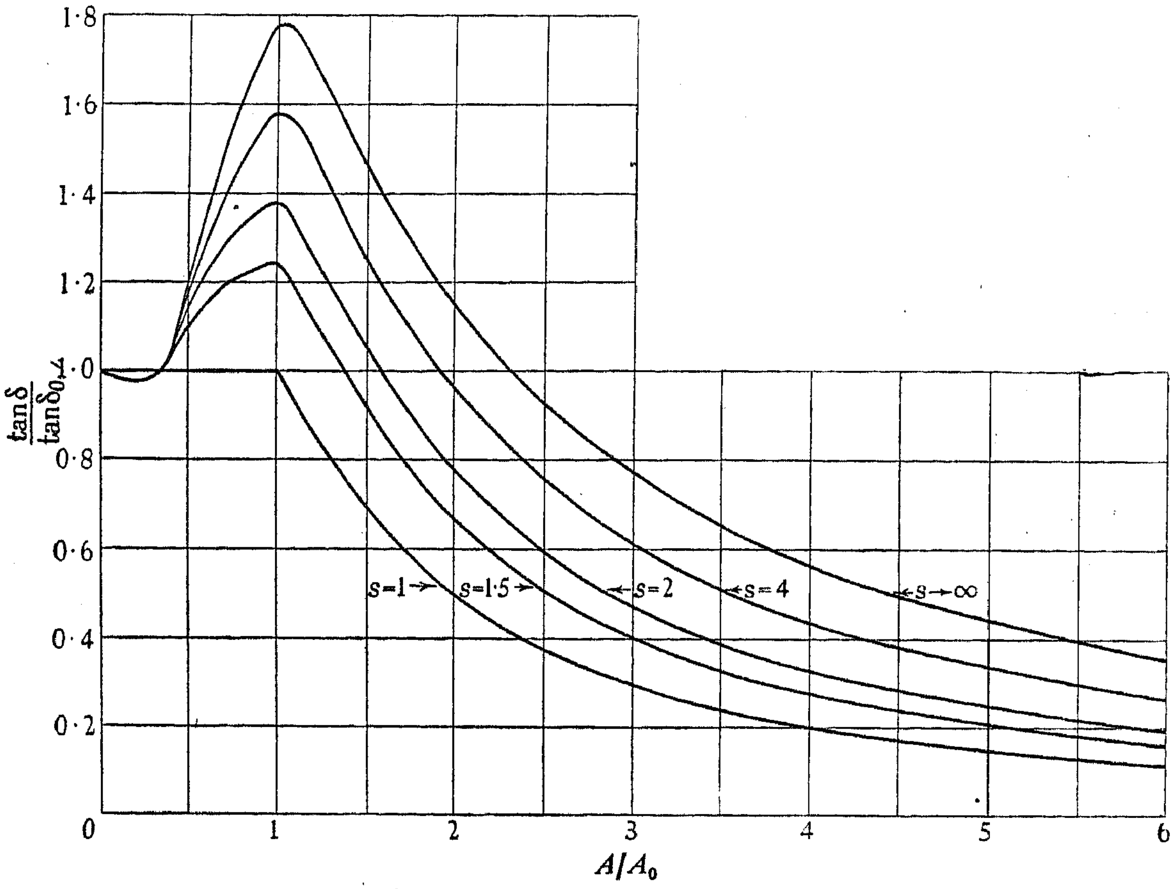


Fig. 2. $\frac{\tan\delta}{\tan\delta_0} = f(A/A_0, s)$. [See equations (1) and (2)].

The mobility $k = \omega d/(2A_0)$ . . . . . (4)

The radius $r = eA_0/(3\pi\omega\eta d)$ . . . (5)

where e = ionic charge;
d = thickness of film;
κ = dielectric constant of the liquid;
η = viscosity of the liquid.

These three equations afford a new method of investigating the nature of ionization in liquid dielectrics.

EXPERIMENTAL

The third section of the paper describes experiments to check the validity of the foregoing theory, by measurement of the loss angle of films of trichlorbenzene about 0·03 mm. thick, between optically plane electrodes. A distillation apparatus, the general construction of which may be seen from Fig. 3, is described in detail. This apparatus permits the loss angle of thin liquid films to be measured while the liquid is being continuously purified by distillation in vacuo.

The results of a number of experiments, under different conditions of distillation, and with various impurities present, are given in some detail and figures given showing the variation of loss angle with voltage in each case. Of these, a typical example is shown in Fig. 4.

The extent to which continued distillation reduces the loss angle varies greatly with the nature of the impurity present, but in one experiment a loss angle as low as 0·001 was reached, and in this case the dependence of the angle upon stress was too small to measure with accuracy.

The extent to which the experimental results confirm the predictions of the theory is shown in Fig. 4 by crosses calculated from equations (1) and (2). Of nine experimental

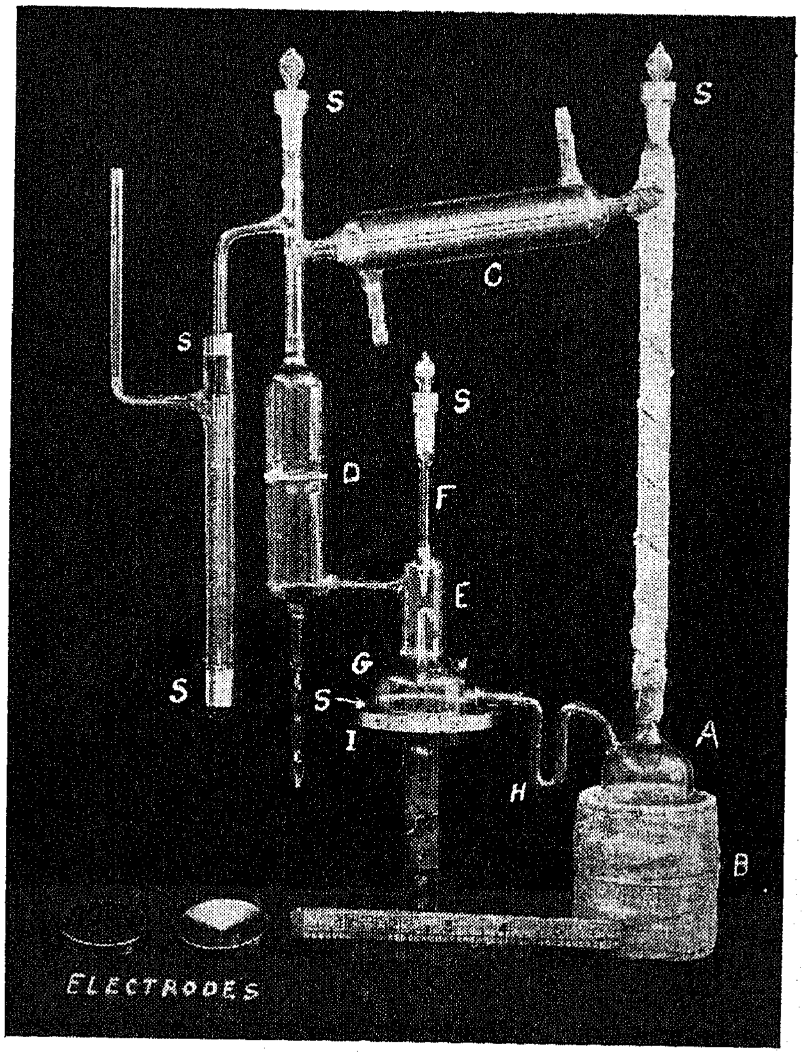


Fig. 3.—Apparatus for the investigation of the dielectric properties of thin films of insulating liquids.

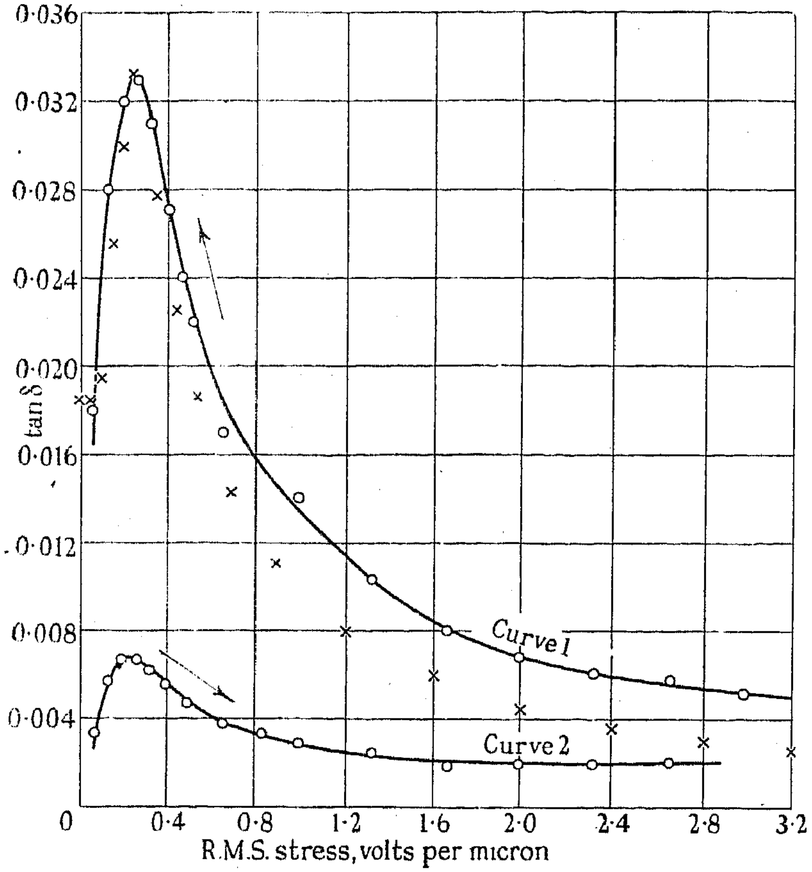


Fig. 4.—Relation between tan δ and electric stress: Experiment 3.
○ Observed values.
× Calculated values.

curves obtained, five agree with the theory to about the same accuracy as in Fig. 4, while the remaining four deviate considerably, apparently due to the presence of some impurity for which the assumptions of the theory are only partially valid. For the five good results, the ionic concentration, mobility and radius are shown in the Table, as calculated from the experimental data by means of equations (3), (4) and (5).

TABLE

Experiment	N_1	k (microns per sec. per volt per cm.)	r (cm.)
3 (1)	10×10^{10}	1·35	$2{\cdot}7 \times 10^{-8}$
3 (2)	2×10^{10}	1·45	$2{\cdot}55 \times 10^{-8}$
7	118×10^{10}	1·45	$2{\cdot}55 \times 10^{-8}$
8	14×10^{10}	1·9	$1{\cdot}95 \times 10^{-8}$
9	24×10^{10}	1·6	$2{\cdot}35 \times 10^{-8}$

The ionic mobility and radius are of the same order of magnitude as those obtained from electrolytic experiments, thus giving an independent check upon the validity of the theory proposed, in addition to that afforded by the agreement in shape of the curves.

APPLICATION OF THE THEORY TO IMPREGNATED DIELECTRICS

In this section the theory is applied to a heterogeneous collection of pore sizes, such as would be met with in impregnated paper. By graphical summation of a number of curves of the type shown in Fig. 2, one for each group of pore sizes, it is possible to account satisfactorily for the shape of the (loss angle)/voltage curves of paper condensers impregnated with a liquid containing ionizable impurities. The agreement obtained is shown in Fig. 1, where the curves represent experimental results and the points have been calculated from the proposed theory.

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